IST-2001-37652

Hard Real-time CORBA

Title

D4.7 PCT Documentation & Evaluation

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Universidad Politécnica de Madrid
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www.hardrealtimecorba.org

Summary Sheet

IST Project 2001-37652
HRTC
Hard Real-time CORBA

PCT Documentation & Evaluation

Abstract:

This document contains the documentation of the Process Control Testbed. It includes all the hardware, equipment and software developed and used in this project to implement and test the PCT.

The identification of this deliverable is D4.7.

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Release Sheet (1)

Release:	**0.1 Draft**
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Sheets	All

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Date:	2003/09/22
Scope	Added Contents
Sheets	All

Release:	**1.0 Final**
Date:	2003/10/10
Scope	Added Contents
Sheets	All

Table of Contents

List of Figures

1 Introduction

Documenting a project is of major importance. A good documentation allows an easy understanding of what is done and how it is done. And it allows future upgrades and maintenance with quite less effort as well.

The documentation presented intends to make clear what are all the components used in the PCT and what is its functionality.

The document distinguishes between hardware (& equipment) and software components. The pattern followed for each of the elements is:

Hardware:
Name
Model
Functionality
Description
Notes
Specifications sheet (in the annex)

Software:
Name
Version
Functionality
Description
Notes
Code reference (the code itself is included in deliverables D4.4 and D4.5).

After the documentation the evaluation of the PCT is introduced. This evaluation is based on all the previous work: Requirements specifications, design specification, PCT implementation and PCT testing.

2 Hardware & equipment documentation

2.1 PCs

Name: Pohl
Model: Dell Dimension 8200
Functionality: Host for the HMI.
Description: Intel Pentium 4 2.0GHz processor
512 MB RAM
GForce 3 video card
Intel PRO/100 S Desktop Adapter
OS: Windows XP and Red Hat Linux 8.0
Notes:
Specifications sheet : Not Available

Name: C3P0
Model: SuperMicro SuperServer SYS-6012-p6 1U
Functionality: Host for the PH Server.
Description: Intel Xeon 1.8 GHz processor
256 MB RAM
1 Intel 82544 Gigabit Ethernet controller
1 Intel 82550 Ethernet controller
OS: Red Hat Linux 9.0



Figure 1: Server 6012

Notes: Only one processor installed
Specifications sheet (Annex A**)**

Name: C3P2
Model: SuperMicro SuperServer SYS-6012-p6 1U
Functionality: Host for the DataBase Server.
Description: Intel Xeon 1.8 GHz processor
256 MB RAM
1 Intel 82544 Gigabit Ethernet controller
1 Intel 82550 Ethernet controller
OS: Red Hat Linux 9.0
Notes: Only one processor installed
Specifications sheet: Annex A

Name: C3P4
Model: SuperMicro SuperServer SYS-5012B-6 1U
Functionality: Host for the Controller.
Description: Intel Xeon 2.0 GHz processor
512 MB RAM PC133
2 Intel® 82559 Ethernet controller
OS: Red Hat Linux 9.0

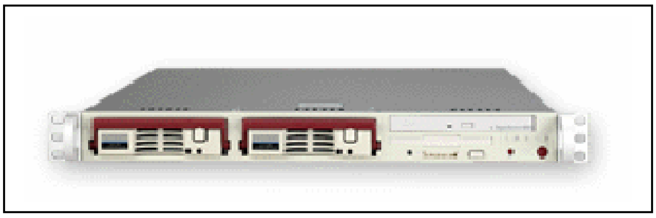


Figure 2: Server 5012

Notes
Specifications sheet Annex B

Name: C3P5
Model: SuperMicro SuperServer SYS-5012B-6 1U
Functionality: Host for the Actuator Server and ICa Name Service.
Description: Intel Xeon 2.0 GHz processor
512 MB RAM PC133
2 Intel® 82559 Ethernet controller
OS: Red Hat Linux 9.0 / RTAI
Notes
Specifications sheet Annex B

2.2 TTTechs Monitoring nodes

Name: TTP-Monitoring Node
Model: TTP-Monitoring Node with TTP-C2 controller (AS8202)
Functionality: The TTP-Monitoring Node is a TTP®-Ethernet gateway node. Based on the TTP-C2 controller (AS8202), it provides powerful facilities for monitoring and download in a TTP network. The TTP-C2 controller has synchronous (MII - 25 Mbit/s) and asynchronous (MFM - 5 Mbit/s) bus interfaces. Both of them are supported.
Description: The TTP-Monitoring Node is connected to a computer via Ethernet (100Base-TX). It supports a standard TCP/IP connection to the computer where TTP-Load runs. TTP-Load is used for downloading software to a TTP cluster. TTP-View monitors an operating TTP network. Both TTPLoad and TTP-View can communicate with the embedded software of the TTP-Monitoring Node via standard TCP/IP Internet protocols.

- Motorola MPC855T PowerQUICC™ integrated communications processor running at
  80 MHz, 32-bit PowerPC® core
- 16 Mbytes external dynamic RAM memory (4 M x 32 bit)
- 8 Mbytes external Flash memory (2 M x 32 bit)



Figure 3: TTTech Monitoring node

Notes: The TTP-Monitoring Node uses an embedded real-time Linux variant and is therefore very easily adapted for specific applications. In addition, the TTP-Monitoring Node is equipped with a PCMCIA card interface for user-specific applications.

Specifications sheet: Annex C.

2.3 Honeywell Distributed Control System (TPS-TDC 3000)

Name: Honeywell Total Plant Solution (TPS)
Model
Functionality: Distributed Control System
Description: The system is composed by:

1. A High-Performance Process Manager (HPM) controller
2. A Global User Station (GUS)
3. A History Module (HM)
4. A Network Interface Module (NIM)
5. A redundant Local Control Network (LCN)
6. A redundant Universal Control Network (UCN)
7. Several I/O cards:
    a. Analog Input (AI)
    b. Analog Output (AO)
    c. Digital Input (DI)
    d. Digital Output (DO)
    e. Serial (Modbus) Interface (SI)



Figure 4: GUS and HPM components.

Notes
Specifications sheet: Annex D

2.4 Data Acquisition cards and modules

Name :PCI DAQ
Model: NI-DAQ 6040E (NI:National Instruments)
Functionality: Data Acquisition Card for PCI slot.
Description: Small device attached to the PCI port of a PC. It can receive and send analog/digital signals. It needs a connector (see below) for the signal transmission. They are used to handle the pumps and to receive the temperature signal.

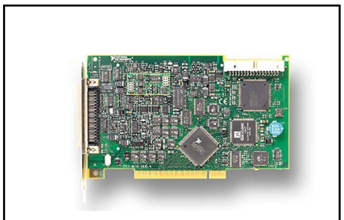


Figure 5: DAQ 6040E

Notes
Specifications sheet Annex E

Name : Connector Block
Model: NI-SCB-68
Functionality: Connects the signal from DAQ cards.



Figure 6: Connector SCB-68

Description: Shielded Input/Output connector block.

Notes
Specifications sheet: Annex F

Name : PCMCIA DAQ
Model: NI-6062E
Functionality: Data Acquisition Card for PCMCIA slot.
Description: Small device attached to the PCMCIA port of the TTTech node. Used to handle pumps.

2 analog outputs; 8 digital I/O lines; two 24-bit counters; analog triggering

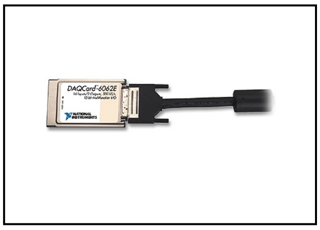


Figure 7: DAQ 6062E

Notes
Specifications sheet: Annex G

Name : Signal conditioning chasis
Model: NI-SC 2345
Functionality:
Description: Shielded carriers for SCC modules. It is a connector block where signal conditioning modules are attached for the connection with DAQ devices as temperature measures. In this project it is used with the pt100 temperature sensor.
Notes
Specifications sheet: Annex H

Name : Temperature signal module
Model: NI-SCC-RTD01
Functionality:
Description: 2-channel module that accepts 2, 3, or 4-wire platinum RTDs. Each channel of the NI SCC-RTD01 has an amplifier with a gain of 25 and a 30 Hz lowpass filter. In addition, each module has a 1 mA excitation source for one or two RTDs.



Figure 8: RTD01

Notes
Specifications sheet: Annex I

Name : Signal isolation module
Model: NI-SCC-AI04
Functionality:
Description: The National Instruments SCC-AI Series consists of dual-channel isolated analog input modules for the SCC signal conditioning system. NI SCC-AI modules accept input voltages from ±50 mV to ±42 V. They are rated for Category II, and provide safety working isolation of 300 V per module. SCC-AI modules are available with either a 4 Hz or 10 kHz lowpass filter.
Notes
Specifications sheet: Annex J

2.5 Ethernet network components

Name: Ethernet communication card
Model: Intel PRO/100 S Desktop Adapter
Functionality: communication through the TCP/IP network
Description: 10/100 Mbps card

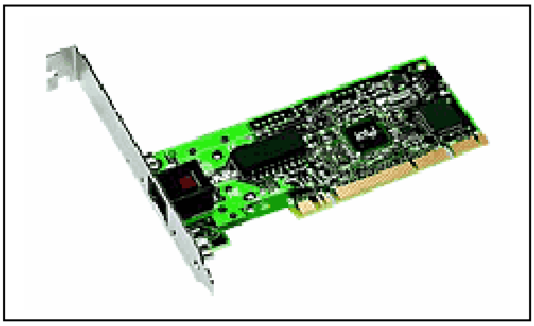


Figure 9: Ethernet card PRO 100

Notes
Specifications sheet: Annex K

Name: Ethernet communication card
Model: Intel 82550 Fast Ethernet Multifunction PCI controller
Functionality: communication through the TCP/IP network
Description: 10/100 Mbps card
Notes
Specifications sheet: Annex L

2.6 Serial (RS232) cable

Name: Serial cable
Model: None
Functionality: Connect the pH meter to a PC through a serial port.
Description: The pH meter can dump all the measurements to the PC via this serial cable. The cable has a standard DB9 floating connector (male) in the PC side, and a RJ9 connector in the pHmeter side. An electrical scheme is provided in the specifications sheet, as well as some other useful data.
Notes
Specifications sheet

2.7 pH sensor

Name: pH meter
Model: Crison GLP21
Functionality: Measure the value of the pH in the reactor
Description: It is a glass electrode that generates a signal proportional to the pH (following Nernst law). It is used in the continuous mode; that is, each (approx.) four seconds, it automatically obtains a pH value and sends it to a PC through the serial port.



Figure 10: pH sensor device

Notes: An special communications protocol is used, so it was necessary to develop an special program which would be able to extract the measure values appropriately (See the software section in this document).
Specifications sheet: Annex O

2.8 Temperature sensor & transmitter

Name: Temperature sensor
Model: pt100
Functionality: Measure the temperature in the reactor.
Description: Four wire temperature sensor.
Notes:
Specifications sheet: Not available

Name: Phoenix Contact temperature transducer for Pt-100
Model: MCR-PT-100-I-DC
Functionality: 4-20 mA transmitter for Pt-100 temperature sensors.
Description: The pasive temperature sensor is connected to the transmitter, who generates a 4-20 mA signal proportional to the temperature.
Notes:
Specifications sheet: Annex D

2.9 Pumps

Name: Process pumps
Model: Micropump LG-187-0024
Functionality: Feed the reactants (acid and base) and the warm water to the reactor.
Description: It is a positive displacement pump. These pumps are used for low-mediums flows. It allows speed control with a signal from 0 to 5VDC. The speed range is from 500 to 4500 rpm. It has a maximum flow of 70ml/min.



Figure 11: Volumetric pumps.

Notes:
Specifications sheet: Annex Q

2.10 Heater module

Name: Heater
Model: Selecta Precis Term 138
Functionality: Keep a storage of hot water at a constant temperature.
Description: It is a basin with an electrical resistance and a temperature sensor. It can be adjusted to keep the temperature at a determined value.



Figure 12: Heater module

Notes:
Specifications sheet: Not available

2.11 Tanks

Name: Acid Tank / Base Tank / Product Tank
Model: Not available
Functionality: Store the reactants and the products of the process.
Description: The tanks are made of glass. They have a capacity of 30liters.



Figure 13: Glass tank.

Notes:
Specifications sheet: Not available.

2.12 Reactor

Name: Neutralization reactor.
Model: Not available.
Functionality: Neutralize the acetic acid with the sodium hidroxide.
Description: A small glass device with its inputs fed to the top and the output comes through a weir.



Figure 14: Glass reactor.

Notes:
Specifications sheet Not available.

2.13 Tubing

Name: Tubing
Model:
Functionality: Connect the different process equipment: tanks, pumps and reactor.
Description: It is a plastic (polypropilene) tubing, semi transparent and with a O.D.=1/8 inches.

Notes:
Specifications sheet: Annex R

3 Software documentation

3.1 Sensors

Name: SensorPH
Version: 2.3
Functionality: A CORBA server used to communicate with the pH meter through the serial port. It provides a method to obtain the pH values from other CORBA clients.
Description: SensorPH manages the serial port communications, and retrieves the information from the pH meter, processes it, and extracts the values. Each time the pH meter sends a new pH value, the program updates an internal data structure with the new data. At any time a CORBA client can call the getPH method served by SensorPH in order to obtain the current pH value in the reactor. SensorPH can be controlled from a local console.
Notes: The IDL interface provides a set of remote control methods that could be used to control the program from a remote host. Those methods are 'empty' in this version; although they can be implemented easily, if necessary.
Code reference D4.4 Chapter 6 pH sensor code documentation

3.2 Actuators

Name:
Version:
Functionality: Send the flow signal to the DAQ.
Description: Corba server that provides methods to change the base, acid and water flow. The actuator server receives the signal in volts between 0 and 5 for each of the 3 pumps, convert it to Comedi (DAQ driver) units and write it in the DAQ.
Notes
Code reference D4.4 Chapter 1 actuator code documentation

3.3 Controllers

Name:
Version:
Functionality: Basic loop controller
Description: Takes the PH from the PH server, makes the proper calculations and send the base and acid target flow to the actuator. In manual operation the controller is stopped, and the signal for the DAQ comes from the user through the HMI. It also send the variables with its time and value tags to the Data Base. The controller implements 2 threads, one of them as an active object.
Notes
Code reference D4.4 Chapter 2 regulator code documentation

3.4 Virtual objects

Name: vsensor
Version: 1.0
Functionality: Simulation of a sensor used in the intensive traffic experiments.
Description: CORBA server program. It provides the same IDL interface that SensorPH, but neither does real communication with a pH meter, nor uses the serial port. It only provides a CORBA method that is used to generate Ethernet traffic. In the intensive traffic experiment, a great amount of this virtual sensor must be created, in order to generate a massive data traffic
Notes: Virtual sensors are created from an auxiliary program, "launcher_s", that creates an specified number of vsensors named VIRTUAL_SENSOR_X, where X is an unique number used by the associated virtual actuator and regulator to communicate with the sensor.
Code reference D4.4 Chapter 9 virtual sensor code documentation

Name: vactuator
Version: 1.0
Functionality: Simulation of an actuator used in the intensive traffic experiments.
Description: CORBA server program. It provides the same IDL interface that the actuators used in PCT. It only provides CORBA methods that are used to generate Ethernet traffic. In the intensive traffic experiment, a great amount of this virtual actuator must be created, in order to generate a massive data traffic.
Notes: Virtual actuators are created from an auxiliary program, "launcher_a", that creates an specified number of vactuators named VIRTUAL_ACTUATOR_X, where X is an unique number used by the associated virtual sensor and regulator to communicate with the actuator.
Code reference D4.4 Chapter 7 virtual actuator code documentation

Name: vregulator
Version: 1.0
Functionality: Simulation of a regulator used in the intensive traffic experiments.
Description: CORBA client program. It uses the sensor and actuator IDL interfaces. This program does not any real regulation work, actually. It only calls the virtual sensor and virtual actuator methods from within an internal loop, in order to generate Ethernet traffic. In the intensive traffic experiment, a great amount of this virtual regulator must be created, in order to generate a massive data traffic. The internal loop has a sleep time that can be configured
Notes: Virtual regulators are created form an auxiliary program, "launcher_r", that creates an specified number of vregulator named VIRTUAL_REGULATOR_X, where X is an unique number, used to communicate with the associated vsensor and vactuator.
Code reference D4.4 Chapter 8 virtual regulator code documentation

3.5 Human Machine Interface

Name:
Version:
Functionality: Graphical user interface.
Description: Provides a graphical interface to the system. It allows the user to change the PCT parameters, send flow signals to the pumps, change the set points, read the variables, etc.
Notes: The HMI has been programmed using the Qt library.
Code reference D4.4 Chapter 3 HMI code documentation

3.6 Database

Name:
Version:
Functionality: Record the PCT variables, values and times.
Description: The data base records the variables for a future analysis. Each variable is recorded with his unique ID, value and time (using the NTP synchronize protocol). It uses 3 tables.
Notes: MySQL data base.
Code reference D4.4 Chapter 4 Database code documentation

3.7 Honeywell DCS Software

Name: TPS
Version: TPN R600 / GUS R201 / APP R101
Functionality:
Description:
Notes:
Code reference:

Configuration files (exception building) for serial modbus interface with wrapper:

```
VOL  PRUE
DEFAULT VOLUME ID   5622
DRED TDC-3000

{IDF NET>PRUE>SERIALI.DB, ENTITY $NM01B03( ) }
PM_BOX    $NM01B03
NTWKNUM   = 01
NODENUM   = 03
NODETYP   = HPM
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NFASTCTL  = 0
NPVSLOT   = 20
NFASTPV   = 0
NLOGSLOT  = 25
NFASTLOG  = 0
NDCSLOT   = 150
NFASTDC   = 0
NDEVSLOT  = 0
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NNUMERIC  = 1024
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KEYWORD   ="        "
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MODNUM    = 0
SLOTNUM   = 1
PRIMMOD   = --
USERID    ="                "
EXTDATA   = IO_NN
IOPNUM    = 5
FTANUM    = 1
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SCANPRI   = HIGH
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STRLEN    = 64
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LSTRDESC   ="
"
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ASSOCDSP  ="        "
UNIT      = 01
NTWKNUM   = 01
NODENUM   = 3
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SLOTNUM   = 2
PRIMMOD   = --
USERID    ="                "
EXTDATA   = IO_NN
IOPNUM    = 5
FTANUM    = 1
DEVADDR   = 12.00
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AUXDATA3  = --------
AB_DATA3  = --------
AUXDATA4  = 9600.100
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NNUMERIC  = 1
STRSTIX   = 0.000
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NTIME     = 0
SPLOCK    = OPERATOR
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```

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LNNDESC    ="
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LSTRDESC   ="
"
LTIMEDESC ="
"


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EUDESC    ="Degree C"
KEYWORD   ="PT-100   "
ASSOCDSP  ="         "
UNIT      = 01
NTWKNUM   = 01
NODENUM   = 03
MODNUM    = 04
SLOTNUM   = 005
PNTMODTY  = HLAI
SENSRTYP  = 1_5_V
PVCHAR    = LINEAR
INPTDIR   = DIRECT
PVEUHI    = 150
PVEULO    = 0.0
PVFORMAT  = D1
PVEXEUHI  = 155
PVEXEULO  = -2.9
PVCLAMP   = NOCLAMP
LOCUTOFF  = --------
TF        = 0.0

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NODETYP   = HPM
PNTFORM   = COMPONNT
PTDESC    ="TEMPERED WATER PUMP     "
EUDESC    ="% OUTPUT"
KEYWORD   ="SY_H0103"
ASSOCDSP  ="         "
UNIT      = 01
NTWKNUM   = 01
NODENUM   = 03
MODNUM    = 01
SLOTNUM   = 005
PNTMODTY  = AO_16
OPTDIR    = DIRECT
OPCHAR    = OFF
OPTOL    = 0.0

{IDF NET>PRUE>T_H013.DB, ENTITY HS_H010_3( ) }
```

```
DICMPNIM  HS_H010_3
NODETYP   = HPM
PNTFORM   = FULL
PTDESC    ="PUMP H010.3 SWITCH      "
EUDESC    ="        "
KEYWORD   ="        "
ASSOCDSP  ="        "
UNIT      = 01
NTWKNUM   = 01
NODENUM   = 3
SLOTNUM   = 5
PRIMMOD   = --
USERID    ="----------------"
NOSTATES  = 2
NODINPTS  = 0
NODOPTS   = 1
PVTXTOPT  = OFF
STATETXT(1)  ="ON      "
STATETXT(0)  ="OFF     "
BOXCLR(1)  = GREEN
BOXCLR(0)  = YELLOW
MOMSTATE  = NONE
LOGICSRC  = --
ST1_OP1   = ON
ST0_OP1   = OFF
DODSTN(1)  = !DO03S05.SO
PULSEWTH  = 1.000000
SEALOPT   = NONE
MAINTOPT  = OFF
NMODATTR  = NONE
MODEPERM  = PERMIT
OROPT     = OFF

{IDF NET>PRUE>T_H013.DB, ENTITY HS_H010_3P( )}
DIOUTNIM   HS_H010_3P
NODETYP   = HPM
PNTFORM   = COMPONNT
PTDESC    ="PUMP H010.3 SWITCH POINT"
EUDESC    ="        "
KEYWORD   ="        "
ASSOCDSP  ="        "
UNIT      = 01
NTWKNUM   = 01
NODENUM   = 03
MODNUM    = 03
SLOTNUM   = 05
PNTMODTY  = DO_32
DOTYPE    = STATUS

{IDF NET>PRUE>T_H013.DB, ENTITY TIC_H013( )}
REGCLNIM TIC_H013
NODETYP   = HPM
PNTFORM   = FULL
```

```
PTDESC    ="                                        "
EUDESC    ="                "
KEYWORD   ="                "
ASSOCDSP  ="                "
UNIT      = 01
NTWKNUM   = 01
NODENUM   = 3
MODNUM    = 0
SLOTNUM   = 5
PRIMMOD   = --
USERID    ="----------------"
CTLALGID  = PIDERFB
PVEUHI    = 100.0000
PVEULO    = 0.000000
PVFORMAT  = D1
PVSRCOPT  = ALL
PVSOURCE  = AUTO
OVERVAL   = 25
BADCTLOP  = NO_SHED
RCASOPT   = NONE
NMODE     = NONE
MODEPERM  = PERMIT
EXTSWOPT  = NONE
SPHILM    = 100.0000
SPLOLM    = 0.000000
SPTOL    = 0.000000
SP        = 2.000000
SPOPT     = NONE
RBOPT     = NORATBI
PIDFORM   = INTERACT
CTLEQN    = EQA
PVTRACK   = NOTRACK
CTLACTN   = REVERSE
GAINOPT   = LIN
K         = 1.000000
T1        = 0.000000
T2        = 0.000000
K1        = 0.000000
NOCINPTS  = 3
CISRC(1)  = SERIAL1.NN(1)
CISRC(2)  = SERIAL1.NN(1)
CISRC(3)  = SERIAL1.NN(1)
NOCOPTS   = 2
CODSTN(1)  = SY_H010_3.OP
CODSTN(2)  = SERIAL2.NN(1)
CVEUHI    = 100.0000
CVEULO    = 0.000000
OPHILM    = 105.0000
OPLOLM    = -5.00000
SAFEOP    = --------
OPMCHLM   = 0.000000
OPROCLM   = --------
OPTOL    = 0.000000
```

```
AUXUNIT = --
BADOCOPT = OFF
OPALDB   = 5.000000
OPHITP   = --------
OPLOTP   = --------
PVALDB   = ONE
PVHITP   = --------
PVLOTP   = --------
PVROCPTP = --------
PVROCNTP = --------
BADPVPR  = LOW
DEVHITP  = --------
DEVLOTP  = --------
ALENBST  = ENABLE
```

3.8 ABACUSS II process model

Name: PCT model
Version: 1.0
Functionality: Simulate the actual PCT.
Description: A model of the real PCT (process + control) has been developed using the modelling environment ABACUSS II [ref]. The model is based on physical and chemical principles. The data to model the pumps have been obtained from the vendor's catalogue. The dissociation constant for the acetic acid have been collected from literature.
Notes: A single model is presented in the code reference. This is the complete model. In the experiments this model is used for operators training. For the interaction between the simulation and the actual controller the same model has been adapted removing the model of the controller and redefining the connections to that sensor and actuator. This second model is not included as is practically contained in the first one.
Code reference: As this model is developed using a simulation language it is not included in any previous documents (D4.4 or D4.5) so the model is described next:

```
#################################################################
#          Model of the PCT of the HRTC Project                 #
# The Process is a neutralization tank with two feeds.          #
# Feed 1 is acetic acid 0.1M                                     #
# Feed 2 is NaOH 0.1M                                            #
# The process has a pH controller.                               #
# The process has a T controller                                 #
#                                                               #
#  --------Author: Manuel Rodríguez,DIQUIMA-ETSII-UPM----------   #
#  --------Last update: April 11 2003 ------------               #
#################################################################
DECLARE

TYPE
  # Identifier    # default   # lower     # upper

  area            = 1        : 0.0       :  10000.0    UNIT= "cm^2"
  concentration   = 0.5      : 0.0       :  100.0      UNIT= "mol/l"
  control_signal  = 1.0      : -1.0E9    :  1.0E9      UNIT= "-"
  dens_mass       = 1000.0   : 0.001     :  1500.0     UNIT= "kg/m3"
  dens_mol        = 50.0     : 1.0E-5    :  150.0      UNIT= "kmol/m3"
  fraction        = 0.5      : 0.0       :  1.0        UNIT= "kmol/kmol"
  flow_mol        = 1000.0   : 0         :  1.0E4      UNIT= "kmol/min"
  flow_vol        = 0.4      : 0.0       :  1.0E4      UNIT= "ml/s"
  height          = 1        : 0.0       :  1000.0     UNIT= "cm"
  holdup_mol      = 2.5      : -1000.0   :  1000.0     UNIT= "mol"
  molefraction    = 0.5      : 0.0       :  1.0        UNIT= "kmol/kmol"
  molweight       = 75.0     : 1.0       :  200.0      UNIT= "kg/kmol"
  notype          = 1.0      : -1.0E9    :  1.0E9      UNIT= "-"
  percent         = 1.0      : 0.0       :  100        UNIT= "%"
  pH              = 4.5      : 0.0       :  14.0       UNIT= "H+"
  pressure        = 1.0      : 0.5       :  10.0       UNIT= "bar"
  revolutions     = 2000     : -100      : 5000        UNIT = "rpm"
```

```
    temperature      = 25       : 0         : 100       UNIT = "C"
    volume          = 10.0    :  0.0      :    200      UNIT= "l"

STREAM

    Process_stream  IS  flow_vol , concentration , temperature

END


#################################################################
MODEL Pump #This model is for the LG-187 of Micropump. Positive displacement pump.
#################################################################
PARAMETER
    parameter_1, Parameter_2 AS REAL #Coefficients of the linear regression

VARIABLE

    Flow AS flow_vol
    Concentration AS concentration
    temperature AS temperature
    V_in AS control_signal
    speed AS revolutions

STREAM
    Inlet : Flow, Concentration, temperature AS Process_stream
    Output : Flow, Concentration , temperature AS Process_stream
    Manipulated : V_in AS CONNECTION
EQUATION

#This equation is a relation between the motor speed and
# the flow (ml/min). The relation is obtained through a linear
# correlation made with data provided by the manufacturer.
# It is checked that the loss of pressure in the system is so slow that
# it has not to be considered in the correlation. Range is from 10ml/min(500rpm)
# to 85ml/min (4500rpm) although best results are in range 18(ml/min)(1000rpm) and
# 72ml/min (4000rpm).

# Pump Characteristic
#A relation between the control signal to the bomb, 0-5volt
# and the motor speed.
    speed=1000*V_in ;
#There is a minimum value (of speed) under which the flow is ZERO.
    IF speed > 50 THEN
    Flow = (Parameter_1 + Parameter_2*speed)/60 ; # 60 para pasarlo a ml/s
    ELSE
    Flow = 0.0 ;
    END

END # Pump


#################################################################
MODEL PI_cont
#################################################################
PARAMETER

    clip        AS  INTEGER

VARIABLE

#   Connection:

    I_in        AS  control_signal
    SP      AS  control_signal
    I_out       AS  control_signal
```

```
#   Internal:

    bias        AS  notype #This is the value when no error occurrs
    error       AS  notype
    gain        AS  notype
    I_error     AS  notype
    min     AS  notype
    max     AS  notype
    C_reset     AS  notype # Or integral time
    value       AS  notype # Output value of the controller

STREAM

    Action  :  I_out       AS  CONNECTION
    Reading :  I_in        AS  CONNECTION

EQUATION

    error       =   SP - I_in;
    $I_error    =   error;
   value       =   bias + gain * (error + I_error / C_reset );

#   Clip if required:

    IF clip = 1 THEN
        IF value > max THEN

            I_out = max;

        ELSE IF value < min THEN
            I_out = min;

        ELSE
            I_out = value;

        END
        END

        ELSE
            I_out = value;

    END
END


#################################################################
MODEL Neut_tank
#################################################################

PARAMETER

  ka AS     REAL              #Equilibrium constant
  vol AS    REAL

VARIABLE


 flow_in_base AS flow_vol
  conc_base_in AS concentration
  flow_in_acid AS flow_vol
  conc_acid_in AS concentration
  conc_acid AS concentration
  conc_acetate AS concentration
  mol_acid AS holdup_mol
  mol_acetate AS holdup_mol
  conc_H  AS concentration
  pH AS pH
  flow_out AS flow_vol
```

```
  flow_in_water AS flow_vol
  conc_water_in AS concentration
  temp_water_in  AS temperature
  temp_base_in AS temperature
  temp_acid_in AS temperature
  temperature AS temperature

STREAM

   Input_water : flow_in_water, conc_water_in, temp_water_in AS Process_stream
    Input_base : flow_in_base, conc_base_in , temp_base_in AS Process_stream
    Input_acid : flow_in_acid, conc_acid_in, temp_acid_in AS Process_stream
    Output   : flow_out, conc_acid, temperature AS Process_stream
    Measured : pH AS CONNECTION
    Measured_T : temperature AS CONNECTION

EQUATION

  conc_acid=mol_acid/vol;
  conc_acetate=mol_acetate/vol;
  $mol_acid=                    flow_in_acid*conc_acid_in/1000-flow_in_base*conc_base_in/1000-
flow_out*conc_acid/1000;

  IF mol_acid >0 THEN
    $mol_acetate=flow_in_base*conc_base_in/1000-flow_out*conc_acetate/1000;

    IF mol_acetate >0 THEN
      conc_H=ka*conc_acid/conc_acetate;
      pH=-LOG(conc_H)/LOG(10);
    ELSE
      pH=14+LOG(conc_acid)/LOG(10);
      conc_H=10^(-14)-conc_acid;
    END

  ELSE
    $mol_acetate=-flow_out*conc_acetate/1000;
    pH= 14+LOG(conc_acid)/LOG(10);
    conc_H=10^(-14)-conc_acid;
  END

  flow_out=flow_in_acid+flow_in_base+flow_in_water;

#Energy balance(It assumes constant Cp=1. This is because reaction heat is negligible and
# both reactants are quite diluted so liquid heat capacity from water is assumed. It also assumes
# same density for all components for the same reason. It can be more exactly formulated, although
# results will not differ significantly)
 temperature                                                                                    =
(flow_in_acid*temp_acid_in+flow_in_base*temp_base_in+flow_in_water*temp_water_in)/flow_out;

END

##################################################################
MODEL Feed_tank
##################################################################

PARAMETER
area AS REAL  #area of the tank

VARIABLE
temperature AS temperature
concentration AS concentration
flow_out AS flow_vol
h AS height

STREAM

 Output : flow_out, concentration , temperature AS Process_stream
```

```
EQUATION

$h=-flow_out/area;


END

####################################################################
MODEL Product_tank
####################################################################

PARAMETER
area AS REAL  #area of the tank

VARIABLE
temperature AS temperature
concentration AS concentration
flow_in AS flow_vol
h AS height

STREAM

 Inlet : flow_in, concentration, temperature AS Process_stream

EQUATION

$h=flow_in/area;


END

####################################################################
MODEL PCT
####################################################################

#   Flowsheet connectivity described in this model.

PARAMETER

    parameter_1, Parameter_2 AS REAL #Coefficients of the linear regression
    clip        AS  INTEGER
    vol       AS REAL
    ka         AS REAL
    area AS REAL  #area of the tank

UNIT

    pump_base, pump_acid, pump_water AS Pump
    phC AS PI_Cont
    n_tank AS Neut_tank
    tank_acid AS Feed_tank
    tank_base AS Feed_tank
    tank_water AS Feed_tank
    tank_product AS Product_tank
    TC AS PI_Cont

EQUATION

#   Connects the controller output to the NaOH pump.

   phC.Action   IS   pump_base.Manipulated ;
   TC.Action IS pump_water.Manipulated;
   pump_base.Output IS n_tank.Input_base ;
    pump_acid.Output IS n_tank.Input_acid ;
   pump_water.Output IS n_tank.Input_water;
   n_tank.Measured IS phC.Reading ;
   n_tank.Measured_T IS TC.Reading;
   pump_acid.Inlet IS  tank_acid.Output;
```

```
  pump_base.Inlet IS tank_base.Output ;
  pump_water.Inlet IS tank_water.Output ;
  n_tank.Output IS tank_product.Inlet;

END

##################################################################

SIMULATION  Neutralization_tank

OPTIONS
CSVOUTPUT := TRUE;

UNIT
   PCT        AS  PCT


SET
   WITHIN PCT DO

    Parameter_2 := 0.018268899 ;
    Parameter_1 := -0.219207388 ;
    clip            :=  1;
    ka := 1.8*0.00001;
    vol := 0.2;
   area := 300;

   END

INPUT

   WITHIN PCT DO

      WITHIN pump_water DO

      Concentration := 0.0 ;
      temperature := 40;

     END

     WITHIN pump_base DO

      Concentration := 0.1 ;
      temperature := 20;

     END

     WITHIN pump_acid DO

      Concentration := 0.1 ;
      temperature := 20;
      V_in :=1.38;

     END

     WITHIN phC DO

     SP := 4.56;
     gain :=15.5;
     bias :=.55;
     C_reset     :=  15.115;
      max     :=  4.5;
      min     :=  0;

     END

     WITHIN TC DO
```

```
      SP := 25;
      gain :=15.5;
      bias :=.55;
      C_reset    :=  15.115;
       max    :=  4.5;
       min    :=  0;

      END

   END

PRESET
   WITHIN PCT DO
       WITHIN  pump_base DO
        speed :=2000;
       END
       WITHIN  n_tank DO
        temperature :=23.8;
        flow_out:= 2.1;
       END
       WITHIN  pump_water DO
        speed :=1380;
       END
   END

INITIAL

   WITHIN PCT DO

      WITHIN phC DO
       I_error = 0.00;
      END
       WITHIN TC DO
       I_error = 0.20;
      END
      WITHIN n_tank DO
       mol_acid = 0.1;
       mol_acetate = (-ka+SQRT(ka^2+4*mol_acid*ka))/2;
      END
      WITHIN tank_acid DO
       h = 200;
      END
      WITHIN tank_base DO
       h = 200;
      END
     WITHIN tank_water DO
       h = 200;
      END
     WITHIN tank_product DO
       h = 0;
      END

   END

SCHEDULE
 SEQUENCE

 CONTINUE FOR 4500.0

 RESET
          WITHIN PCT.phC DO
            C_reset := 1.915;
     END
           WITHIN PCT.TC DO
            C_reset := 1.915;
     END

 END
```

```
 CONTINUE FOR 500.0

RESET
          WITHIN PCT.pump_acid DO
             concentration := 0.15;
           END
END
CONTINUE FOR 2500.0
END

END
```

3.9 Simulator wrapper

Name: Simulator
Version: 1.1.
Functionality: A CORBA wrapper for the Abacuss II model of the PCT.
Description: It implements an IDL interface in order to talk to the PCT regulator CORBA object. This interface provides two methods used to write values to, and read values from, the Abacuss II model.
Notes:
Code reference D4.4 Chapter 10 simulator wrapper code documentation

3.10 NTP ethernet clock synch

Name:Network Time Protocol

Version: 4.1.1a-9

Functionality: Synchronize the PC clocks.

Description: NTP provides the protocol mechanisms to synchronize time in to precisions in the order of nanoseconds. The protocol provisions to specify the precision and estimated error of the clock and the characteristics of the reference clock to which it be synchronized. However, the protocol itself specifies only data representation and message formats and does not specify synchronizing algorithms or filtering mechanisms

Notes
Code reference Not available

3.11 Modbus wrapper

Name
Version
Functionality: Provides a Corba wrapper to access Modbus.
Description: Implements Modbus protocol over serial line, to interface TPS via the Serial Interface.

It implements 2 threads. The first one acts as a Corba server waiting for requests to write or read from the modbus. The other one is an active object to send data to the Actuator and Data Base
Notes: Based on the LibModbus library.
Code reference D4.4 Chapter 5 Modbus wrapper code documentation

3.12 Data Acquisition Cards drivers

Name: DAQ drivers
Version: Comedi
Functionality: Allow communication between the DAQ card and the RTAI Linux operating system.
Description:
Notes:
Code reference:

3.13 Operating system and compiler

Name: Linux Red Hat
Version: 9.0
Functionality: main operating system for the TCP nodes
Description:
Notes: In the node H007.2, RTAI is also used as a module into the RedHat base operating system.
Code reference: Not available

Name: GCC
Version: 3.2
Functionality: C and C++ compiler
Description: GCC is the GNU Compiler Collection, which currently contains front ends for C, C++, Objective-C, Fortran, Java, and Ada, as well as libraries for these languages (libstdc++, libgcj,...).
Notes: gcc was used through an IDE, KDevelop 2.1.5
Code reference: Not available

3.14 CORBA distribution

Name: ICa (Integrated Control Architecture)
Version: 1.0.1
Functionality:

- Bridge the separation of an object's interface from its implementation.
- Provide, to the client, an interface to access objects.
- Locate the correct object for each client request.
- Transmit messages from the client to the object.

Description: ICa is composed by a set of tools and libraries targeted at distributed intelligent computing for industrial control applications. **ICa** is based in the CORBA standard (OMG, 1998) and is specifically built for the development of industrial applications.
Notes
Code reference Not available

4 Evaluation

4.1 Ethernet experiments

Experiment 4.1a: CCS Ethernet loop

The experiments made with the Hub and with the Switch show that the timing properties of the control loop are sufficient for process control, where reaction times go from 5-10 milliseconds in the field level to 100ms in the control network level. The loop cycle of the experiment is around 10 ms in both cases (hub and switch). The overhead imposed by using the CORBA middleware is low and non significant.

In this experiments the actuator and the sensor have been wrapped with the CORBA layer through the use of a PC. In the actual process industry CORBA should go embedded in the instrument itself, taking into advantage that the current trend is towards digital, “intelligent” devices. This means that the footprint should be quite small as the memory of this devices is low.

CORBA calls should be non-blocking (oneway) in order to avoid additional latency and to get stalled when an instrument fails. (It is better to use the “last measurement” until the device is restored or the back up unit is on line).

CORBA implementation should allow that a client be alive even when the server goes down, and to automatically detect when the server goes up again and connect to it.

Experiment 4.2: Legacy systems integration

The possibility and characteristics of the integration of legacy sytems in CCS are fundamentally determined by the facilities provided by vendors of that system, not CORBA. For control purposes, in the case of the TPS the fastest access to the controller node (HPM) is achieved via the Serial Interface (SI).

This interface has several limitations in temporal behaviour and capacity. For read operations:

- 80 SI connections at 1 second scan period
- 40 SI connections at ½ second scan period
- 20 SI connections at ¼ second scan period

For write requests, the number of consecutive write data requests is limited to 16, after which, one array point read request is issued. Further, constant writes to the serial interface (for example, a logic output) can overload the system and degrade performance.

In conclusion, the integration of the TPS in a CCS system is possible but constrained in capacity and scan period. Additionally, there is uncertainty in the temporal behaviour. This allows some degree of integration in typical process plants but is not the ideal case.

Experiment 4.5: Interaction between simulation and control

This is an off-line experiment. The integration of ABACUSS II and the HMI and the interaction with the actual regulator has been easy using CORBA. This has been due to the availability of the simulator as a library. The CORBA object has wrapped the simulator interface and linked to the library to obtain the final CORBA simulation object. The use with commercial simulators is not so straightforward. Although the Cape Open initiative (for open simulation using CORBA or COM) that enables the use of components of different simulator could be a way to achieve a more wide and generic integration between CORBA objects and COTS simulators.

The use of real time simulation on line needs to extend CORBA to handle the notion of time to interact with the simulator. One approach is to use the standard RTI (HLA) for distributed simulation and extend it to real time.

Experiment 4.6: Intensive data traffic

The transmissions size in the field level are traditionally small (field networks communicate at a rate of 32kb/s) but the use of digital devices will increase the size significantly (although being small). The control level uses high rate transmission networks (10/100Mb/s).

The experiments performed on the Hub network show that the loop performance degrades under a heavy load on the network. The single collision domain makes that the latency increases as well as its variability.

The switched Ethernet can cope with the heavy load of the network but there is a limit which is set by the capacity of the switch. A Switched Ethernet could be used then for process control without further consideration. But although the load in the process control network layers is not very high it can eventually go beyond the switch capacity. As the process control layer has to be predictable a limit has to be set, and at least a worst case scenario is needed.

The use of CORBA with an standard wide used network as Ethernet is appealing for the process control domain as the control layers can flatten, costs can be reduced and information be available to any node in the system. This poses a security problem (and possible network collapse) and so it is critical to control the information flow between the control and the business layer.

Experiment 4.7: Concurrent access

The experiments performed on the Hub network show a control loop performance degradation. Latency times and its variability are increased. The switch Ethernet experiment is also affected by the concurrency access, although results are still good for process control.

It is clear that a priorities policy is needed for process (and any) control systems. The regulator should have the highest priority accessing the pH value. But for large and complex control systems where predictability (or at least a Worst Case) is a must it is advisable to use deadlines instead of priorities (you have to know when –in the worst case- is going to happen). This is something that has to be implemented in CORBA.

CORBA has proved to handle very well requests at a very high rate as all the elements performed (specially the pH sensor) well in this experiments.

4.2 TTP Experiments

Experiment 4.1.b: CCS TTP loop
Experiment 4.3: Sequence of events generation
Experiment 4.8: Merging networks

These experiments have not been developed as the TTP protocol has been received after the last day of the project (September 30th).

By that time the experiments where designed and some examples running under the TTP network but with the IOP protocol were programmed and tested.

The CCS TTP loop will be implemented and the results will be sent as an addendum to this deliverable and deliverable D4.6.

Besides the lack of the experiments some conclusions can be stated about using TTP for process control systems.

It has the advantage of being completely predictable which is very important for any control system but:

-It is not flexible, everything has to be known in advance so a proper design can be done. This can be useful for "not changing" systems as may be a car or an airplane but it is not for process control where the control configuration can change (due to many reasons, new control loop configuration, revamping of the process, …).

-It is oriented only to time triggered events. The event time has to be known in advance. In process control state events happen and have to be accounted for.

-The way it operates through a broadcast of the information to all the nodes is opposed to the CORBA client/server philosophy.

The first two drawbacks could be overcome reserving (empty) slots for new nodes and checking at every time slot if an state event has happened. This solves (in part) the problem but is not how TPP has been designed to work.

Finally a process control system has to important elements that don't need hard real time requirements: the Human Machine Interface and the Historical Module (or Database). This means that the TTP network should be accessed from the Ethernet network. This poses the problem of a CORBA gateway communicating two different protocols on the TTTech Node. Other problems are related with the low memory of the nodes (as all the variables are broadcasted this can be a problem in a network with thousands of signals), or how "non control" functions available since digital instruments are present can be performed on the TTP network, functions as device information for maintenance analysis, on-line software changes,…

4.3 Overall evaluation and conclusions of the Process Control Testbed

CORBA is a potential element to incorporate to process control systems. Many features make it really attractive but there are features missing as deadlines (better than priorities) for requests. The overhead imposed is not significant for the loop timing properties, it can cope with concurrent requests and it works well with multiple objects (around two hundred objects and 6000 thousand signals were alive in the intensive traffic experiment). It is more than an alternative to OPC for process control systems.

Due to the additional complexity, they have not been implemented in the PCT, but fault tolerance in networks and nodes is a must in controls systems. A redundant network and some components are the norm in current process control.

Another issue not explored (due to the scope of the project) is configuration. CORBA could allow the automatic detection of new nodes in the control network, what can be seen as something good or convenient, but it is intrinsically dangerous, since it can compromise the operation of the system. The classic approach in process control systems implies a configuration step where a rigid definition of the nodes and connections are established. Maybe, some degrees of freedom or convenience in CORBA are welcome, but control systems in plants are unlikely to not have a well defined configuration. This means that specific components (like configuration utilities) and specifications (like the ones that enforce configuration) would have to be developed, or even better, become an

standard, if CCS is to be used by industry. It is important to distinguish between the reconfiguration needed in process control (when a new configuration –nodes- is needed it has to be well-defined) and the redesign of the control system that is needed if TTP is used.

Many of those CCS components and specifications should be oriented to safety: Safe operation of process plants is essential because they process large quantities of toxic or explosive material and accidents can lead to important losses in terms of human life, property and the environment.

One of the aspects is error management in a complex software system. The classic approach has been relatively simple systems with reliable connections. The potential flexibility of CCS is a risk that should be minimized, perhaps leading to some loss of that flexibility. Another necessity is the provision of diagnostic tools for CCS.

On the other hand, real-time is not very exigent in most of the process control applications. Lag times in instruments and equipments are in the order of, at last, hundreds of milliseconds and the networks used up to day are much less than what we have in Ethernet.

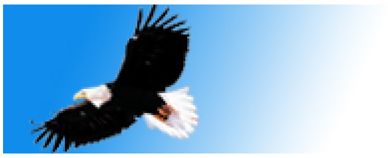
So real time Ethernet is the best solution to use with CORBA in process control systems as it can provide a predictable but more flexible environment and the use of a widely used technology as it is Ethernet.

5 Annexes

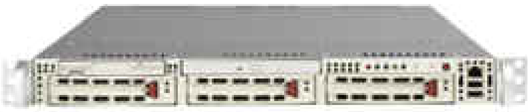
4.4 List of Annexes

Annex A: PC 6012
Annex B: PC 5012
Annex C: TTTech Monitoring Node
Annex D: Temperature transmitter & TPS
Annex E: DAQ 6042E
Annex F: SCB 68 connector
Annex G: DAQ 6062E
Annex H: Conector SCC 2345
Annex I: RTD-01
Annex J: SCC AI-04
Annex K: Ethernet Card PRO/100
Annex L: Ethernet Card 82550
Annex O: pHmeter Crison GLP 21
Annex Q: Pumps Micropum LG-187
Annex R: Tubing

Annex A: PC 6012



SUPERMICRO®
A Server Solutions Manufacturer





The SuperServer **6012P-6** offers the high performance of dual Xeon(tm) power in a sleek 1U rackmount configuration. Based on an Intel E7500-chipset mainboard, the super dense 6012P-6 is making waves within the industry with such features as dual Intel® Xeon(tm) Processors of up to 2.80GHz with a 512K L2 cache, 8GB of ECC registered DDR-200 memory and dual channel Ultra160 SCSI with *three* hot-swap SCSI hard drive bays. This robust system provides build-as-you-grow scalability for Internet, ISP, and application computing needs. Built with the superior quality and performance that has made Supermicro famous, the 6012P-6 is a density-optimized 1U solution that will provide long-term satisfaction in a variety of applications.

**D/L PDF System Spec.
**D/L PDF Chassis Spec.
**D/L PDF Manual

SuperServer 6012P-6 (SYS-6012-P6)



Motherboard	• SUPER P4DPR-6GM+
CPU	• Dual Intel® Xeon™ Processors up to 2.80GHz with 512K L2 cache
Memory	• Up to 8GB ECC registered PC1600 DDR SDRAM memory* • 4 two-way interleaved memory modules provide outstanding memory performance • 25 degree slots for better airflow
Front Side BUS	• 400MHz
Chipset	• Intel® E7500
I/O Expansion	• 1 64-bit, 133MHz PCI-X (full length) • 1 64-bit, 66MHz PCI (low profile) • 1 VXB
Onboard I/O Devices	• Adaptec AIC-7899W dual channel Ultra 160(320) SCSI controller • Intel 82544 Gigabit Ethernet controller • Intel 82550 Ethernet controller • 1 Adaptec Zero-channel SCSI RAID controller (2005S) support as an optional • (IPMI)1.5 (OEM optional) • ATI Rage XL 8MB PCI graphic controller • Dual Ultra DMA (**UDMA/100**) bus master/EIDE channels support data transfer rates of up to 100 MB/sec • 2 Fast UART 16550 compatible serial ports • 4 USB ports • PS/2 keyboard and mouse ports

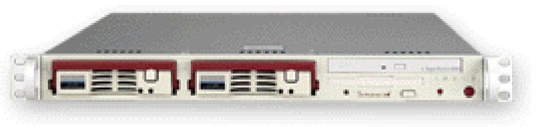
Chassis	• SC812 (CSE-812S-400P)
Form Factor	• **1U Rackmount**
Power Supply	• 400W cold-swappable power supply **(PWS-0036)** • Auto-switching 100/240 AC power
SCA Subsystem	• 3 Hot-swap Ultra160 SCA 1" SCSI drive bays (SAF-TE compliant, for one-inch high, 80-pin SCA SCSI drives) • SCA backplane provides power, bus termination
Cooling Subsystem	• 2 10cm heavy-duty blower fans
External Drive Bays	• 1 Slim 1.44MB Floppy drive • 1 Slim CD-ROM
Other Features	• ACPI/APM power management • Onboard AOL2 (Alert-on-LAN2) controller chip (optional) • PC'99 color-coded I/O connectors • WOL (wake-on-LAN) connector • Internal/external modem wake-up • Control of power-on mode for recovery from AC power loss • Chassis intrusion detection
PC Health Monitoring	• 4 Onboard voltage monitors for CPU • 4 Fan status • Environmental temperature monitor and control • Chassis and CPU overheat alarm, LED indication and control • System resource alert • Supermicro System Management utility
Dimensions	• Width: 16.8 in. • Height: 1.7 in. • Depth: 25.6 in. • Weight: ~22 lbs. (net) ~39 lbs. (gross)
BIOS	• 4Mb Flash ROM • BIOS rescue recovery feature • Hardware BIOS virus protection • ACPI/APM power management PnP • PXE headless support

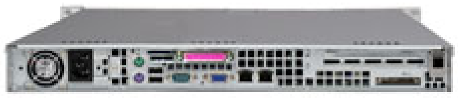
* This product has been designed to support 2GB DIMM modules for each memory slot, but it has only been validated on 1GB memory modules.

Annex B: PC 5012

SUPERMICRO
A Server Solutions Manufacturer

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Looking for the ideal entry-level server? Look no further! The SuperServer 5012B is your answer. Featuring a single Intel® Pentium® 4 Processor of up to 2.80GHz, the SuperServer 5012B offers two different models to suit your needs. The 5012B-6 model offers an Adaptec AIC-7899 dual channel Ultra160 SCSI controller and two hot-swappable SCSI HD bays for outstanding availability and scalability. If you are working within a budget, the 5012B-E model with the IDE solution may be the one for you. Both models come with the superior performance and the product quality Supermicro products are known for. Supermicro offers a comprehensive set of density-optimized solutions that are proven to solve any challenges that customers encounter when they deploy servers in a racked environment.

**D/L PDF System Spec.
**D/L PDF Chassis Spec.
**D/L PDF Manual

SuperServer 5012B-6 (SYS-5012-B6)

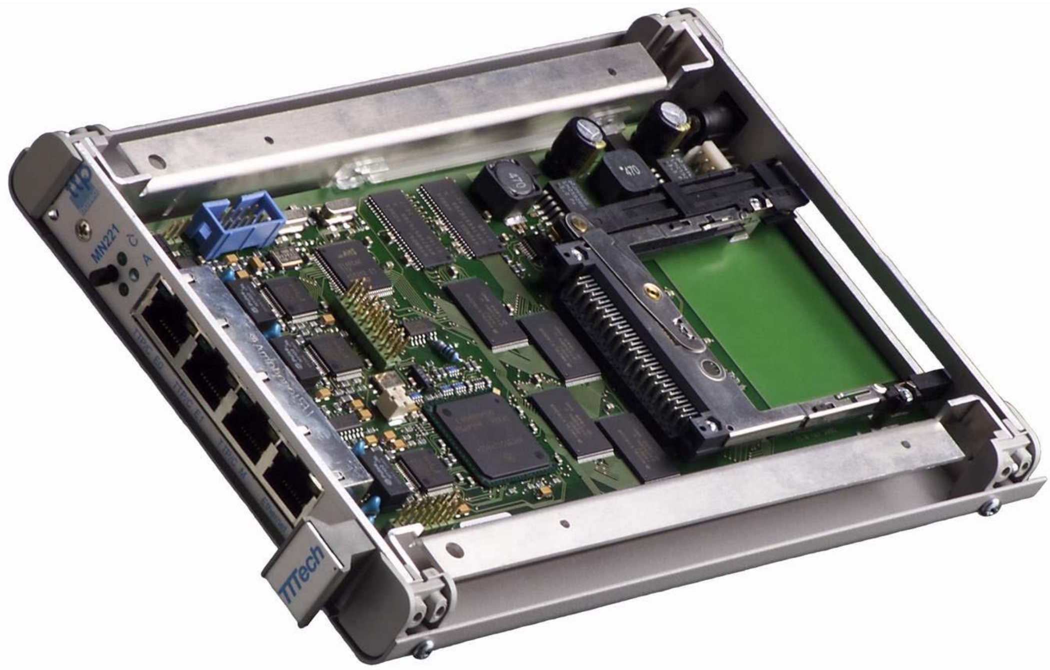


Motherboard	• SUPER P4SBR
CPU	• Single Intel® Pentium® 4 Processor of up to 2.80GHz
Memory	• Up to 3GB PC133/100 unbuffered SDRAM memory*
Front Side BUS	• 400MHz
Chipset	• Intel 845
I/O Expansion	• 1 32-bit, 33MHz PCI
Onboard I/O Devices	• Adaptec AIC-7899 dual channel Ultra160 SCSI controller • Dual Ultra DMA **(UDMA/100MB/s)** • Burst data transfer rate supports UDMA Mode 5, PIO Mode 4, ATAPI • 2 Intel® 82559 Ethernet controller • ATI Rage XL 8MB PCI graphic controller • 2 USB (Universal Serial Bus) ports • PS/2 keyboard and PS/2 mouse connectors • 2 fast UART 16550 compatible serial ports • 1 ECP/EPP parallel port • 1 Infrared port • 1 floppy port
BIOS	• 4Mb AMI FWH • BIOS rescue recovery feature • Hardware BIOS virus protection • ACPI/APM power management PnP • PXE headless support

Chassis	• SC810P4 (CSE-0057-P)
Form Factor	• **1U Rackmount**
Power Supply	• 250W power supply (PWS-0021) • Auto-switching 100/240 AC power
SCA Subsystem	• 2 Hot-swap Ultra160 SCA 3.5" SCSI drive bays (for one-inch high, 80-pin SCA SCSI drives) • SCA backplane provides power, bus termination
Cooling Subsystem	• 1 10 cm. blower fan
External Drive Bays	• 1 Slim 1.44MB Floppy drive • 1 Slim CD-ROM
Other Features	• ACPI/APM power management • Onboard AOL2 (Alert-on-LAN2) controller chip (optional) • PC'99 color-coded I/O connectors • WOL (wake-on-LAN) connector • Internal/external modem wake-up • Control of power-on mode for recovery from AC power loss • Chassis intrusion detection
PC Health Monitoring	• 4 Onboard voltage monitors for CPU • 4 Fan status • Environmental temperature monitor and control • Chassis and CPU overheat alarm, LED indication and control • System resource alert • Supermicro System Management utility
Dimensions	• Width: 16.7 in. • Height: 1.7 in. • Depth: 22 in. • Weight: 17.6 lb. (Net) 22 lb. (Gross)

* This product has been designed to support three 1GB DIMMs, but it has only been validated with the 512MB memory modules.

Annex C: TTTech Monitoring Node



^{TTP}Monitoring Node – The TTP-Ethernet Gateway

^{TTP}Monitoring Node is a TTP®-Ethernet gateway node. Based on the TTP-C2 controller (AS8202), it provides powerful facilities for monitoring and download in a TTP network. The TTP-C2 controller has synchronous (MII – 25 Mbit/s) and asynchronous (MFM – 5 Mbit/s) bus interfaces. Both of them are supported.

Ethernet Connection to Computer

The ^{TTP}Monitoring Node is connected to a computer via Ethernet (100Base-TX). It supports a standard TCP/IP connection to the computer where ^{TTP}Load runs. ^{TTP}Load is used for downloading software to a TTP cluster. ^{TTP}View monitors an operating TTP network. Both ^{TTP}Load and ^{TTP}View can communicate with the embedded software of the ^{TTP}Monitoring Node via standard TCP/IP Internet protocols.

Real-time Linux and PCMCIA Interface for User Flexibility

The ^{TTP}Monitoring Node uses an embedded real-time Linux variant and is therefore very easily adapted for specific applications. In addition, the ^{TTP}Monitoring Node is equipped with a PCMCIA card interface for user-specific applications.

Host CPU

- Motorola MPC855T PowerQUICC™ integrated communications processor running at 80 MHz, 32-bit PowerPC® core
- 16 Mbytes external dynamic RAM memory (4 M x 32 bit)
- 8 Mbytes external Flash memory (2 M x 32 bit)

Interfaces

- TTP interface (based on the TTP-C2 controller AS8202) with
  MFM on RS 485 physical layer (5 Mbit/s asynchronous, 2 channels) and
  MII on IEEE 802.3 100Base-TX physical layer (25 Mbit/s synchronous, 2 channels, requires hub and star architecture)
- PCMCIA slot of type I/II
- Dedicated TCP/IP 100Base-TX network link to a hub, switch, or PC network card
- Multi-channel serial communication interface (PCB-mounted connectors)
- Serial interface on PCB-mounted connectors suitable for TTP/A, LIN, and ISO-K
- Online debug interface (BDM)
- Communication and application status LEDs on front panel
- Reset button on front panel

Specifications

- Dimensions: 220 x 145 x 26 (in mm)
- Weight: 770 g
- Operating temperature: 0 °C – +70 °C
- Storage temperature: -40 °C – +85 °C
- Housing and power supply included
- Power requirements: input voltage 9 - 60 V DC at max. 10 Watt and max. 1.5 A

Subject to changes and corrections.

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A-1040 Vienna, Austria

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Fax: +43 1 585 34 34-90

E-mail: products@tttech.com
Web: www.tttech.com

Temperature transmitter documentation

ENGLISH

MCR Temperature Transducer for PT 100

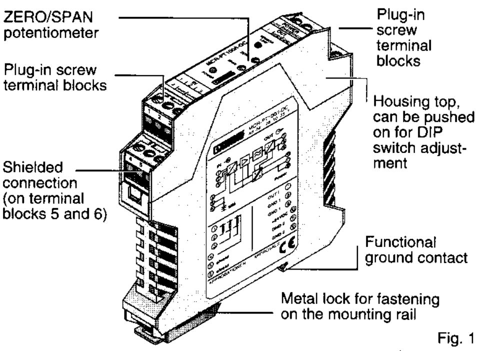
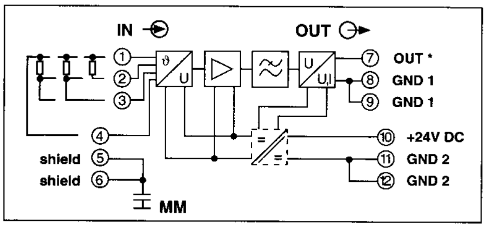


Fig. 1

1. Block Diagram



* OUT I for modules with current output (I output)
OUT U for modules with voltage output (U output)

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2. Short Description

A universal temperature transducer for different temperature measuring ranges is now available in the form of the MCR-PT 100 converters. The supplied auxiliary power can be electrically isolated as an option.

The shield of the sensor cable can be directly connected to integrated connecting terminal blocks. This creates a capacitive connection to the mounting rail via the integrated functional ground contact and improves the discharging of interferences.

A wire break is indicated by a "sensor line" LED.

The DIP switches can be used to set:

- the connection technique and temperature range
- the output signals 0…20 mA or 4…20 mA (with devices with current output).

A ZERO/SPAN compensation is possible via potentiometers on the front.

The selected module is configured in the factory according to the requirements indicated with the device type key and is thus supplied to the user **calibrated for operation.**

3. Function

The MCR-PT 100 modules convert the measured values of the PT 100 sensor (IEC 751/DIN IEC 751) into standardized electrical analog signals.

The sensor is supplied with a small current by the module. The resulting voltage drop is amplified in the module and converted into a signal proportional to the temperature. For linearization of the resistance characteristic, the measurement signal is subsequently fed back to the input. The output circuitry provides the standardized analog signal.

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4. Connection (adjustable via DIP switches)

2-wire connection (Fig. 2a)

For short distances (<10 m).

It must be taken into account that the line resistances R_{L1} and R_{L2} go directly into the measurement result and distort it correspondingly.

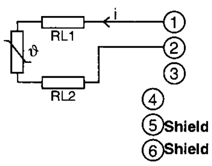


Fig. 2a

3-wire connection (Fig. 2b)

For long distances between the PT 100 sensor and the MCR component and **identical** line resistances ($R_{L1} = R_{L2} = R_{L3}$).

Note:
The line resistance per conductor must not exceed a value of 50 Ω.

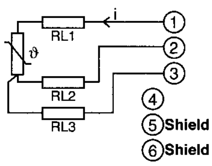


Fig. 2b

4-wire connection (Fig. 2c)

For long distances between the PT 100 sensor and the MCR component and **different** line resistances ($R_{L1} \neq R_{L2} \neq R_{L3} \neq R_{L4}$).

Note:
The line resistance per conductor must not exceed a value of 50 Ω.

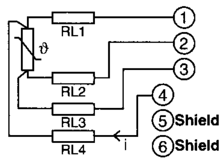
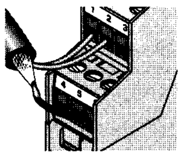


Fig. 2c

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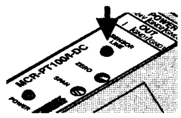
- **Shielded connection** (Fig. 3)

The shielded terminal blocks **"5"** and **"6"** are capacitively connected with the **top-hat rail laid at ground potential** via the functional ground contact. Interferences that occur are dissipated in this way.


Fig. 3

- **Wire break** (Fig. 4)

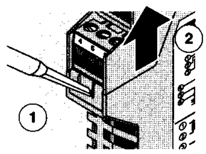
In the case of a **wire break,** the output is overmodulated and the red LED "sensor line" lights up.


Fig. 4

- **Opening the device**

(for configuration – Fig. 5)

The latch of the housing top is unlocked on both sides using a screwdriver ①.
The housing top and the electronics can now be pulled out by about 3 cm ②.


Fig. 5

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5. Configuration (Fig. 6)

You can adjust the basic settings of your device (connection technique, temperature range, of modules with current output: analog output signal 0…20 mA or 4…20 mA) according to the configuration table by using a labelled DIP switch inside the housing.

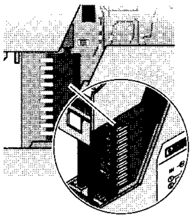


Fig. 6

Configuration table

DIP switch		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Connection technique	2-wire	ON	OFF	ON							
	3-wire	ON	ON	OFF							
	4-wire	OFF	OFF	OFF							
Temperature range	-50… 50°C				ON	OFF	OFF	OFF	OFF		
	-50…100°C				ON	OFF	OFF	ON	OFF		
	-50…150°C				ON	OFF	ON	ON	OFF		
	-50…250°C				ON	OFF	ON	OFF	ON		
	0…100°C				OFF	ON	OFF	OFF	OFF		
	0…150°C				OFF	ON	OFF	ON	OFF		
	0…200°C				OFF	ON	ON	ON	OFF		
	0…300°C				OFF	ON	ON	OFF	ON		
Module with U output	0…10 V									OFF	OFF
Module with I output	0…20 mA									OFF	ON
	4…20 mA									ON	OFF

Every time the input, temperature range or output is changed, the ZERO/SPAN compensation (see p. 17/18) must be performed.

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5.1. ZERO/SPAN Compensation

Required devices: PT100 simulator or decade resistor, voltmeter or ammeter

a) Connect a 24 V supply voltage to terminal blocks ⑩ and ⑪. The LEDs "POWER" and "sensor line" must light up.

> ⚠ **Observe a module warm-up time of 3 minutes before the compensation procedure!**

b) Connect the PT100 simulator or decade resistor according to "4. Connection" (page 15) and set a temperature of 0 °C or the corresponding resistor value. The LED "sensor line" should no longer light up.

c) Zero point calibration:

- Use the PT100 simulator or decade resistor to set a nominal value depending on the temperature range (see table 1).
- Calibrate the output signal value (U_{OUT} or I_{OUT}) with the **ZERO** potentiometer:

Table 1: Zero point calibration

Temp. range	U output module 0…10 V: Nominal value	U output module 0…10 V: U_{OUT} (± 3 mV)	I output module: Nominal value	I output module 0…20 mA: I_{OUT} (± 5 µA)	I output module 4…20 mA: I_{OUT} (± 5 µA)
-50… 50°C	**-50 °C (80.31 Ω)**	0 mV	**-49 °C (80.70 Ω)**	200 µA	4160 µA
-50…100°C				133 µA	4107 µA
-50…150°C				100 µA	4080 µA
-50…250°C				67 µA	4053 µA
0…100°C	**0 °C (100 Ω)**	0 mV	**1 °C (100.39 Ω)**	200 µA	4160 µA
0…150°C				133 µA	4107 µA
0…200°C				100 µA	4080 µA
0…300°C				67 µA	4053 µA

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d) End value calibration:

- Use the PT100 simulator or decade resistor to set a nominal value depending on the temperature range (see table 2).
- Calibrate the output signal value (U_{OUT} or I_{OUT}) with the **SPAN** potentiometer.

Table 2: End value calibration

Temp. range	Nominal value	U output 0…10 V U_{OUT} (± 3 mV)	I output 0(4)…20 mA I_{OUT} (± 5 µA)
-50… 50°C	**50°C (119.40Ω)**	10.000 V	20.000 mA
-50…100°C	**100°C (138.50Ω)**		
-50…150°C	**150°C (157.31Ω)**		
-50…250°C	**250°C (194.07Ω)**		
0…100°C	**100°C (138.50Ω)**	10.000 V	20.000 mA
0…150°C	**150°C (157.31Ω)**		
0…200°C	**200°C (175.84Ω)**		
0…300°C	**300°C (212.02Ω)**		

Repeat points c) and d) once each!

6. Device Type Key

Order example: MCR-PT100/ 3 / -50/100 / 2 / DC
① ② ③ ④

① Connection technique

2 ≙ 2-wire technique
3 ≙ 3-wire technique
4 ≙ 4-wire technique

② Temperature range

-50/ 50 ≙ -50 - 50 °C
-50/100 ≙ -50 - 100 °C
-50/150 ≙ -50 - 150 °C
-50/250 ≙ -50 - 250 °C
0/100 ≙ 0 - 100 °C
0/150 ≙ 0 - 150 °C
0/200 ≙ 0 - 200 °C
0/300 ≙ 0 - 300 °C

③ Output signal

0 ≙ 0 - 10 V
1 ≙ 0 - 20 mA
2 ≙ 4 - 20 mA

④ Electrical isolation

0 ≙ no electrical isolation
DC ≙ input/aux. power supply and output/aux. power supply

The sensor type key is used to specify the configuration of the characteristic values of the device when you order a temperature transducer.

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7. Technical Data

Type / order number	**MCR-PT 100...**	
without electrical isolation	**.../U** 2810340	**.../I** 2810353
with electrical isolation	**.../U-DC** 2810311	**.../I-DC** 2810337
Measurement (input)		
Input	PT 100 (DIN IEC 751); 2-, 3-, 4-conductor connection	
Temperature range	-50… 50 °C, -50…100 °C -50…150 °C, -50…250 °C 0…100 °C, 0…150 °C, 0…200 °C, 0…300 °C	
Supply current (PT 100)	approx. 1 mA	
Connection type	plug-in screw connection	
Measurement (output)	**...PT 100/U(DC)**	**...PT 100/I(DC)**
Output signal	0…10 V	0(4)…20 mA
Load	≥ 10 kΩ	≤ 500 Ω
General data		
Supply voltage	20…30 V DC	20…30 V DC
Current consumption	20 mA (35 mA)	45 mA (60 mA)
Test voltage (supply/meas. circuit)	750 V, 50 Hz, 1 min.	
Transmission error	≤ 0.4 % of end value	
Compensation:		
ZERO (-50 °C)	approx. ± 11 K	
(0 °C)	approx. ± 15 K	
SPAN	approx. ± 5 %	
Ambient temperature range	- 20 °C to + 65 °C	
Temperature coefficient	< 0.02 %/K	

Dimensions (W / H / D)	(17.5 / 99 / 114.5) mm
Conductor cross section	0.2 - 2.5 mm^2 (AWG 24-14)
Housing material	polyamide PA non-reinforced

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CE In conformance with the EMC guideline 89/336/EEC and with the low-voltage guideline 73/23/EEC

EMC (Electromagnetic Compatibility)

Immunity to interference acc. to EN 50082-2

• Electrostatic discharge (ESD)	EN 61000-4-2	criterion B 8 kV air discharge
• Electromagnetic HF field: amplitude modulation pulse modulation	EN 61000-4-3	criterion A 10 V/m 10 V/m
• Fast transients (burst)	EN 61000-4-4	criterion B I/O/S[1)]: 2 kV/5 kHz
• Surge current loads	EN 61000-4-5	criterion B I/O[1)]: 1 kV/2kV/42 Ω S[1)]: 0.5 kV/2 Ω/12 Ω
• Conducted interference	EN 61000-4-6	criterion A I/O/S[1)]: 10 V

Noise emission acc. to EN 50081-2

	EN 55011	class A

These results were achieved with shielded conductors!

EN 61000 corresponds to IEC 1000
EN 55011 corresponds to CISPR11

[1)] I ≙ Input / O ≙ Output / S ≙ Supply

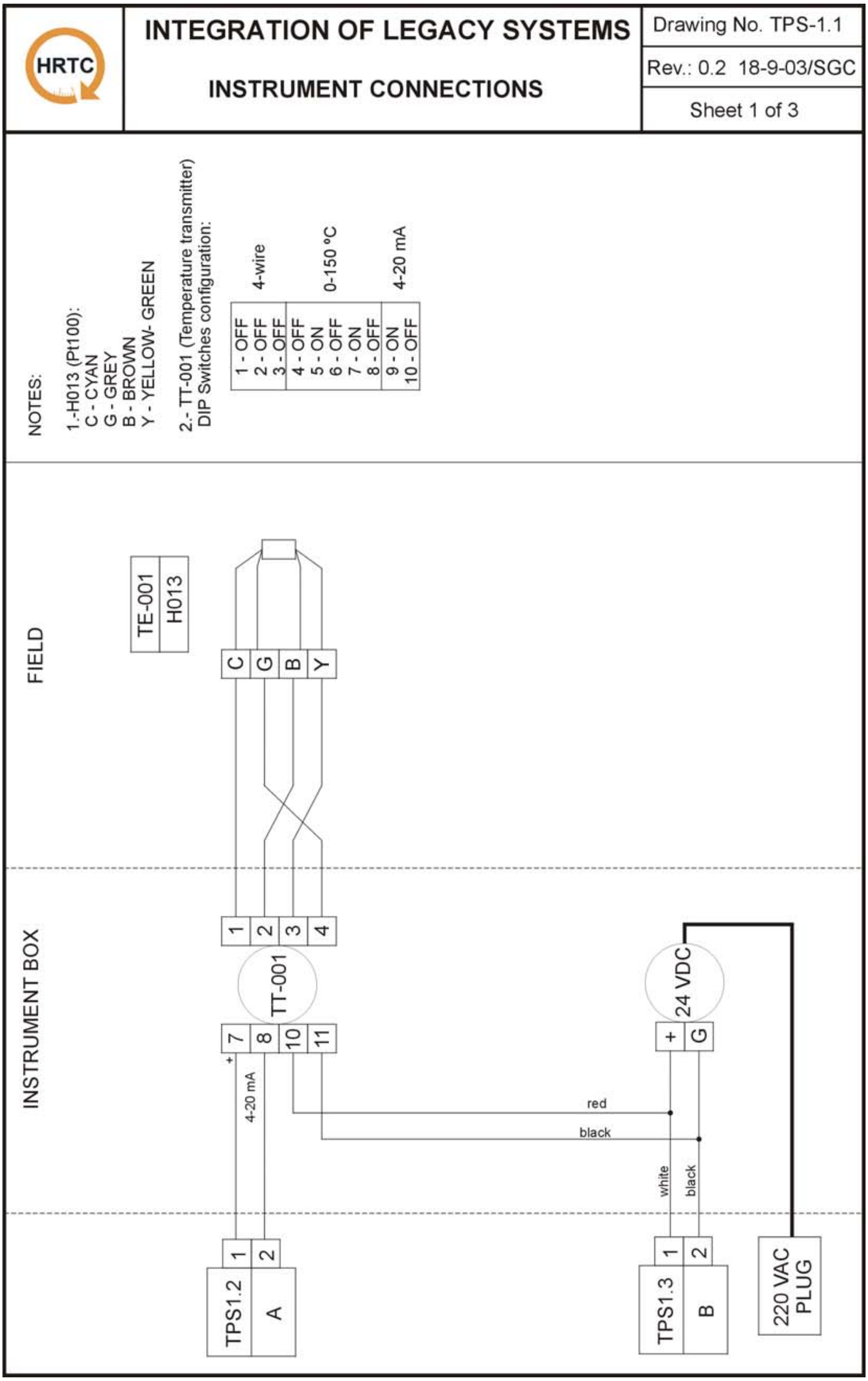
Criterion A: Normal operational behavior within the determined limits.

Criterion B: Temporary disturbance of the operational behavior, which the device corrects itself.

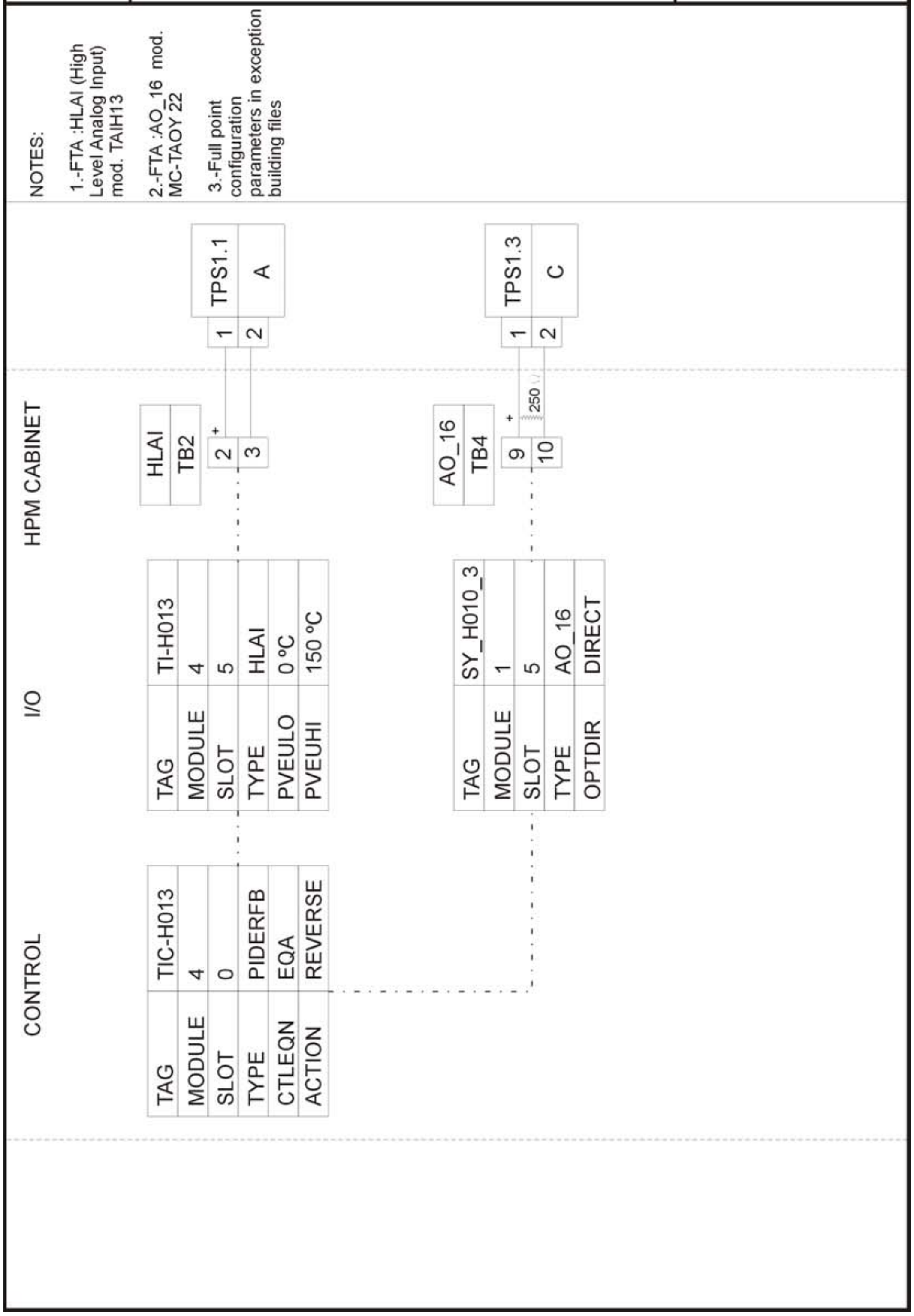
Class A: Industrial areas of application, no special installation measures.

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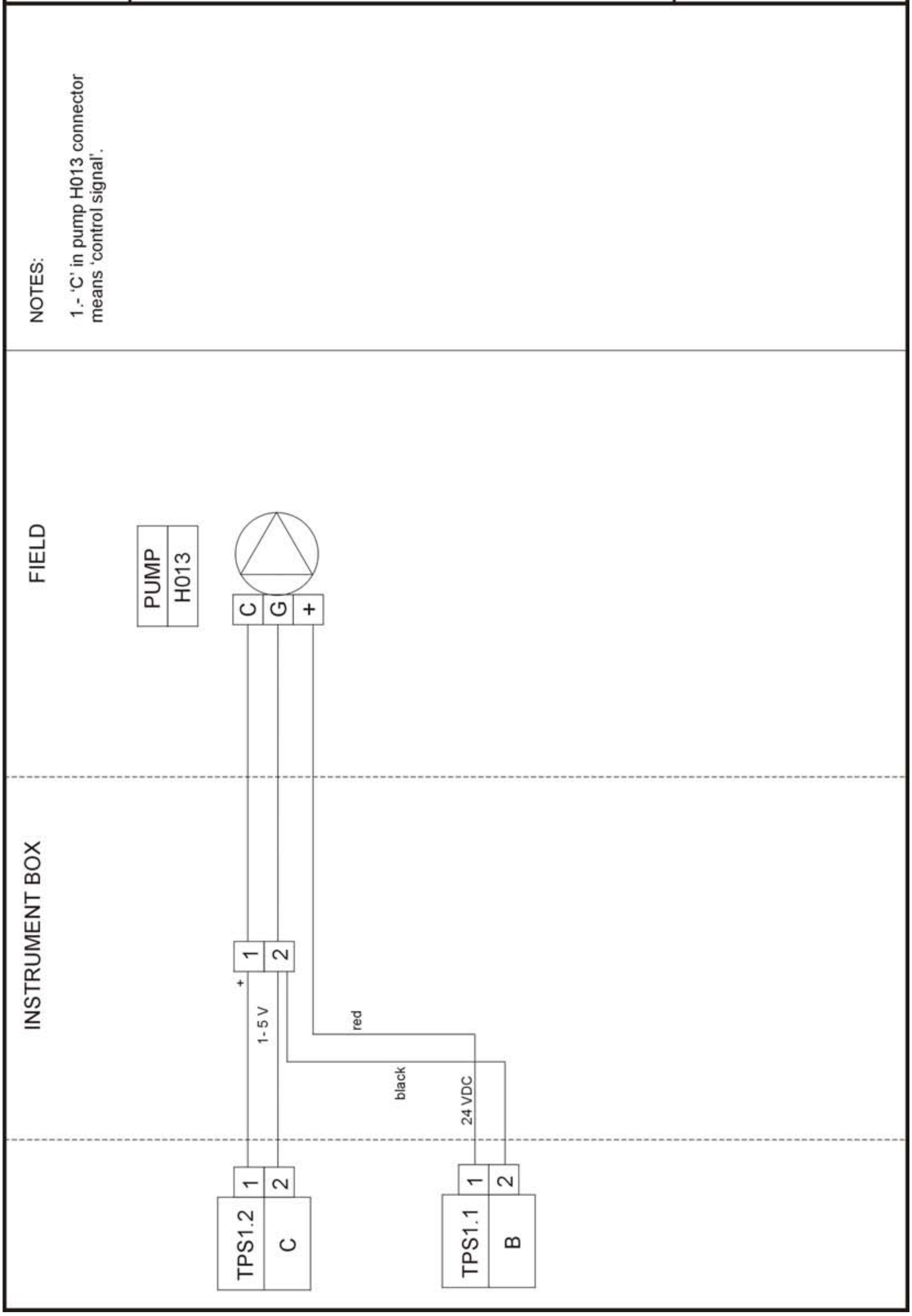
TPS: Instruments connections


HRTC
INTEGRATION OF LEGACY SYSTEMS
INSTRUMENT CONNECTIONS
Drawing No. TPS-1.1
Rev.: 0.2 18-9-03/SGC
Sheet 1 of 3
NOTES:
1.-H013 (Pt100):
C - CYAN
G - GREY
B - BROWN
Y - YELLOW- GREEN
2.- TT-001 (Temperature transmitter)
DIP Switches configuration:
1 - OFF
2 - OFF
3 - OFF
4-wire
4 - OFF
5 - ON
6 - OFF
7 - ON
8 - OFF
0-150 °C
9 - ON
10 - OFF
4-20 mA
FIELD
TE-001
H013
C G B Y
INSTRUMENT BOX
1 2 3 4
TT-001
7 8 10 11
24 VDC
+ G
4-20 mA
red
black
white
black
TPS1.2
A
1 2
TPS1.3
B
1 2
220 VAC
PLUG

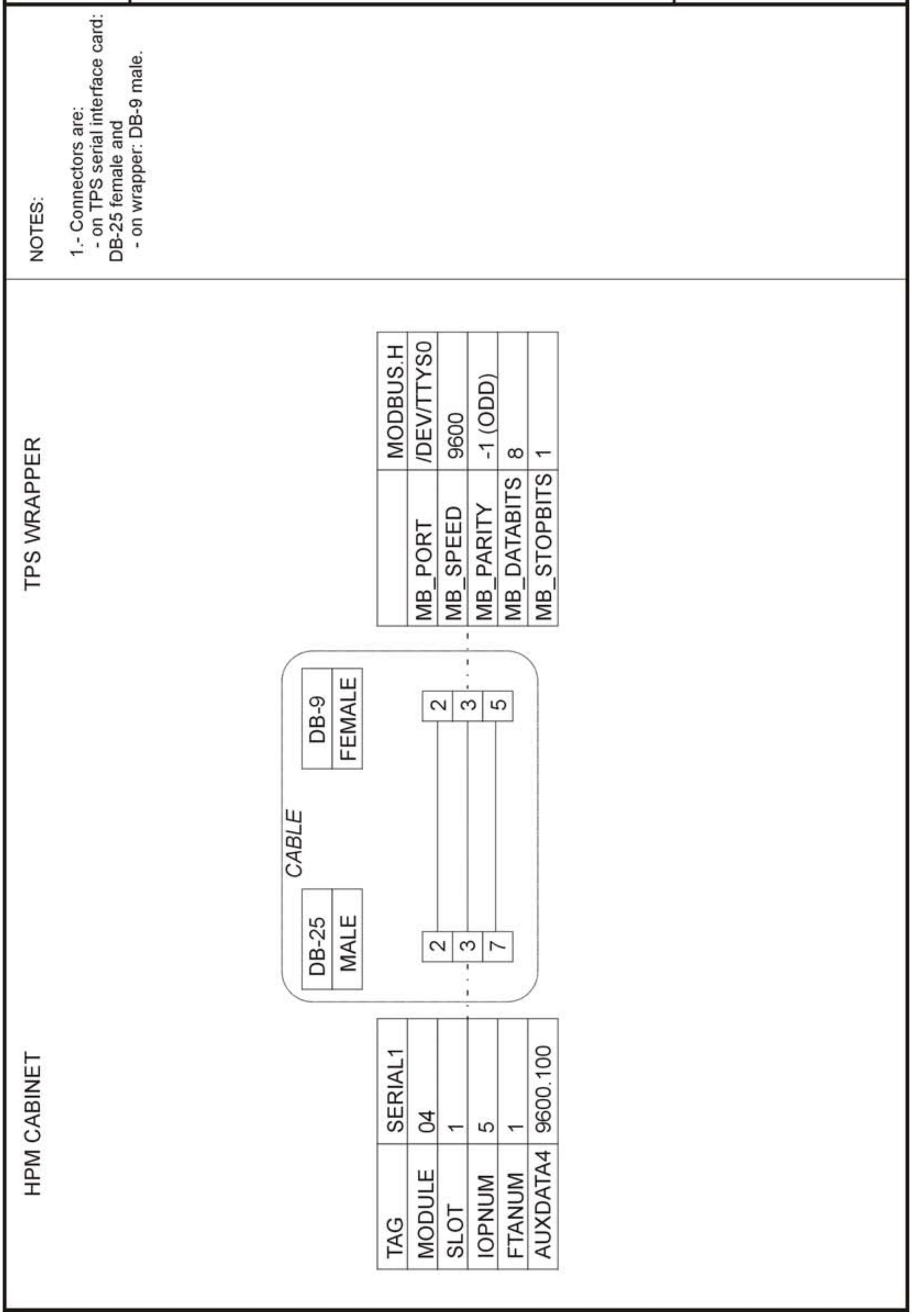
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		Rel.: 0.2 18-9-03/SGC
	INSTRUMENT CONNECTIONS	Sheet 2 of 3



HRTC	**INTEGRATION OF LEGACY SYSTEMS**	Drawing No. TPS-1.3
	INSTRUMENT CONNECTIONS	Rev.: 0.2 18-9-03/SGC
		Sheet 3 of 3



HRTC	**INTEGRATION OF LEGACY SYSTEMS**	Drawing No. TPS 2.1
	TPS - WRAPPER CONNECTION	Rel.: 0.1 19-9-03/SGC
		Sheet 1 of 1



E Series Multifunction DAQ – 250 kS/s, 12-Bit, 16 Analog Inputs

NI 604xE

NI 6040E (MIO-16E-4)
PCI-MIO-16E-4
PXI-6040E
NI 6041E (AI-16E-4)
DAQCard-AI-16E-4

Analog Inputs
16 single-ended, 8 differential channels
500 kS/s single channel scanning
250 kS/s multichannel sampling rate
250 kS/s stream-to-disk rate[†]
12-bit resolution

Analog Output (6040E only)
2 channels, 12-bit resolution

Digital I/O
8 (5 V/TTL) lines

Counter/Timers
2 up/down, 24-bit resolution

Triggering
Analog and digital

Real-Time
See page 184.

Driver Software
NI-DAQ
Windows 2000/NT/Me/9x
Mac OS

Application Software
LabVIEW
Measurement Studio
VirtualBench
Measure
Lookout

Calibration Certificate Included
See page 256.



Consider the DAQCard-6062E; see page 317.

Ordering Information

NI 6040E
PCI-MIO-16E-4 777383-01
PXI-6040E 777484-01

NI 6041E
DAQCard-AI-16E-4 777230-01
Includes NI-DAQ for Windows 2000/NT/Me/9x and Mac OS.

Extended warranty and value added services ....page 880

Recommended Configurations

Family	DAQ Device	Accessory	Cable
NI 6040E	PCI-MIO-16E-4	SCB-68 (776844-01)	SH6868-EP (184749-01)
	PXI-6040E	TBX-68 (777141-01)	SH6868-EP (184749-01)
NI 6041E	DAQCard-AI-16E-4	SCB-68 (776844-01)	PSHR68-68 (777293-01)

See page 334 for accessory and cable information.

Overview

The NI 6040E and NI 6041E DAQ devices use E Series technology to deliver high performance and reliable data acquisition capabilities to meet a wide range of application requirements. You get up to 500 kS/s single-channel (250 kS/s scanning), 12-bit performance on 16 single-ended analog inputs. Depending on your type of hard drive, these devices can stream to disk at rates up to 250 kS/s.

These E Series DAQ devices feature analog and digital triggering capability, as well as two 24-bit, 20 MHz counter/timers; and 8 digital I/O lines. The NI 6040E devices also feature two 12-bit analog outputs.

See the E Series Multifunction DAQ Overview on page 306 for a more detailed hardware overview.

[†]Except for DAQCard-AI-16E-4

GO EXPRESS CODES

For information or to buy products online, visit ni.com/catalog and enter:

pcimio16e4
pxi6040e
daqcardai16e4

BUY ONLINE!

Family	Bus	Analog Inputs	Resolution	Sampling Rate	Input Range	Analog Outputs	Resolution	Output Rate	Output Range	Digital I/O	Counter/ Timers	Triggers
NI 6040E	PCI, PXI/CPCI	16 SE/8 DI	12 bits	500/250[1] kS/s	±0.05 to ±10 V	2	12 bits	1 MS/s	±10 V	8	2, 24-bit	Analog and Digital
NI 6041E	PCMCIA	16 SE/8 DI	12 bits	500/250[1] kS/s	±0.05 to ±10 V	–	–	–	–	8	2, 24-bit	Analog and Digital

[1]Single-channel/multichannel rate

Table 1. NI 604xE Channel, Speed, and Resolution Specifications (see page 344 for detailed specifications)

Multifunction DAQ Accessories



Figure 5. BNC-2090 Shielded BNC Adapter Chassis



Figure 6. CA-1000 Configurable Signal Conditioning Enclosure



Figure 7. TB-2705 Terminal Block



Figure 8. SCB-68 and SCB-100 Shielded I/O Connector Blocks



Figure 9. TBX-68 I/O Connector Block

BNC-2090 Shielded BNC Adapter Chassis (see Figure 5)

The BNC-2090 is a shielded, rack-mountable adapter with signal-labeled BNC connectors, spring terminal blocks, and component locations for passive signal conditioning. Consists of 22 BNC connectors and 28 spring terminals to simplify connection to your analog, digital, trigger and counter/timer signals. The BNC-2090 has silk-screened component locations that you use to develop simple signal conditioning circuits. For added flexibility, you can connect any E Series DAQ device to the BNC-2090 from the front or rear through dual 68-pin connectors.

BNC-2090 777270-01
Dimensions – 48.3 by 4.4 by 18.8 cm (19.0 by 1.7 by 7.4 in.)

CA-1000 Configurable Signal Conditioning Enclosure (see Figure 6)

The CA-1000 is a configurable enclosure that gives you maximum user-defined connectivity and flexibility through customized panelettes. Each enclosure can accommodate up to nine panelettes.
Dimensions – 30.7 by 25.4 by 4.3 cm (21.1 by 10 by 1.7 in.)

See page 352 for more information about the CA-1000.

TB-2705 Terminal Block for 68-pin PXI E Series Devices (see Figure 7)

The TB-2705 is a screw terminal block for PXI that works with your PXI E Series DAQ module. It latches to the front of your PXI module with locking screws and provides strain relief and easy access to your analog, digital, trigger and counter/timer signals through screw terminals.

TB-2705 778241-01
Dimensions – 8.43 by 10.41 by 2.03 cm (3.32 by 4.1 by 0.8 in.)

SCB-68 and SCB-100 Shielded I/O Connector Blocks (see Figure 8)

The SCB-68 and SCB-100 are shielded I/O connector blocks for rugged, very low-noise signal termination for connecting to 68-pin or 100-pin E Series DAQ devices, respectively. Silk-screened component locations for easy addition of simple signal-conditioning circuitry for your analog input channels. They also include general-purpose breadboard areas (two on the SCB-68; three on the SCB-100) as well as an IC temperature sensor for cold-junction compensation in temperature measurements.

SCB-68 776844-01
Dimensions – 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in.)
SCB-100 776990-01
Dimensions – 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in.)

TBX-68 I/O Connector Block with DIN-Rail Mounting (see Figure 9)

The TBX-68 is a termination accessory with 68 screw terminals for easy connection of field I/O signals to 68-pin DAQ devices. It includes one 68-pin male connector for direct connection to 68-pin cables. The TBX-68 is mounted in a protective plastic base with hardware for mounting on a standard DIN rail.

TBX-68 777141-01
Dimensions – 12.50 by 10.74 cm (4.92 by 4.23 in.)

Annex G: DAQ 6062E

Portable Multifunction DAQ
12 or 16-Bit, up to 1.25 MS/s, up to 16 Analog Inputs

NEW

NI DAQPad-60xxE, NI DAQCard-60xxE

- 16 single-ended analog inputs
- Up to 1.25 MS/s, 12-bit resolution or 333 kS/s, 16-bit resolution
- 2 analog outputs, 12 or 16-bit resolution
- 8 digital I/O lines (5 V/TTL); two 24-bit counter/timers
- Available for FireWire, USB, and PCMCIA
- Digital and/or analog triggering
- NI-DAQ driver simplifies configuration and measurements

Models
- DAQCard-6036E ***NEW!***
- DAQCard-6062E
- DAQCard-6024E
- DAQPad-6052E for FireWire ***NEW!***
- DAQPad-6070E for FireWire
- DAQPad-6020E for USB

Operating Systems
- Windows 2000/NT/XP/Me/9x for DAQCards
- Windows 2000/XP/Me/98 for DAQPads
- Others such as Linux (page 187)

Recommended Software
- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual Basic
- VI Logger

Other Compatible Software
- Visual Basic
- C/C++

Driver Software (included)
- NI-DAQ

Calibration Certificate Included
See page 21



Overview and Applications

National Instruments portable data acquisition products deliver the same functionality available in PCI and PXI E Series DAQ devices in a portable format. The DAQPad devices are hot swappable and available in up to three different configurations. The 15 cm enclosure is ideal for desktop, mobile, or portable applications and features a 68-pin shielded connector. The 30 cm enclosure with mass termination offers a low-profile package that fits under your laptop computer. It features a 68-pin shielded connector to connect to signals from our SCC modular signal conditioning products or from our CA-1000 custom connectivity enclosure. The 30 cm enclosure with BNC connectivity is ideal for applications that require portability and quick connectivity, such as in-vehicle automotive or aircraft testing and portable data logging.

NI DAQCards are Type II, PC Card compliant and give the same performance as their PCI or PXI counterparts. However, their compact design makes them ideal for applications where space constraint is an important concern, such as in field service and research.

Features

The NI portable DAQ devices offer a wide range of functionality for FireWire (IEEE 1394), USB, and PCMCIA. In addition to 12 or 16-bit analog input and output resolution and high sampling rates, all devices feature two 24-bit 20 MHz counter/timers and eight digital I/O lines.

Family	Bus	Analog Inputs	Input Resolution	Sampling Rate	Input Range	Analog Outputs	Output Resolution	Output Rate	Output Range	Digital I/O	Counter/ Timers	Triggers
DAQCard-6036E	PCMCIA	16 SE/8 DI	16 bits	200 kS/s	±0.05 to ±10 V	2	16 bits	1 kS/s	±10 V	8	2, 24-bit	Digital
DAQCard-6062E	PCMCIA	16 SE/8 DI	12 bits	500 kS/s	±0.05 to ±10 V	2	12 bits	850 kS/s	±10 V	8	2, 24-bit	Analog, Digital
DAQCard-6024E	PCMCIA	16 SE/8 DI	12 bits	200 kS/s	±0.05 to ±10 V	2	12 bits	1 kS/s	±10 V	8	2, 24-bit	Digital
DAQPad-6052E	FireWire	16 SE/8 DI	16 bits	333 kS/s	±0.05 to ±10 V	2	16 bits	333 kS/s	±10 V	8	2, 24-bit	Analog, Digital
DAQPad-6070E	FireWire	16 SE/8 DI	12 bits	1.25 MS/s	±0.05 to ±10 V	2	12 bits	1 MS/s	±10 V	8	2, 24-bit	Analog, Digital
DAQPad-6020E	USB	16 SE/8 DI	12 bits	100 kS/s	±0.05 to ±10 V	2	12 bits	20 S/s	±10 V	8	2, 24-bit	Digital

Table 1. NI Portable DAQ Products

Annex H: Connector SCC-2345

Portable Modular DAQ Systems
SCC Signal Conditioning Overview

NI SCC

- Signal conditioning for DAQ systems
- Up to:
  - 16 analog inputs
  - 8 digital I/O lines
  - 2 unconditioned counter/timer I/O lines
- Measurement type and connectivity selectable on a per-channel basis
- Low-profile carriers for portable, rack-mount, and desktop applications
- NI-DAQ driver software simplifies configuration and measurement

Sensors/Signals
- Thermocouples
- RTDs
- Strain gauges
- Force/load/torque sensors
- Accelerometers
- Isolated voltage/current input
- Frequency input
- Lowpass filtering
- Isolated voltage/current output
- Isolated digital I/O
- Relay switching

Connectivity Options
- BNC
- Minithermocouple
- Thermocouple
- LEMO (B-series)
- MIL-Spec
- 9-pin D-Sub
- Banana jack
- SMB
- Momentary pushbutton switch
- Toggle switch
- Rocker switch
- LED
- Potentiometer
- Strain relief



Overview
National Instruments SCC provides portable, modular signal conditioning to your DAQ system. SCC conditions a variety of analog I/O and digital I/O signals. With this modular design, you choose your conditioning on a per-channel basis. SCC systems offer custom connectivity options, matching your sensor or signal connection type. While the low-profile carrier is perfect for use with PCMCIA DAQCards and DAQPads for portable applications, you can also use the system for rack-mounted or desktop applications. SCC modules works with E Series and basic multifunction DAQ devices.



Figure 1. SC-2345 with Configurable Connectors

SCC DAQ Systems
SCC DAQ systems consist of an SC-2345 Series shielded carrier, SCC modules, an DAQ device, and a cable. Each carrier can hold up to 20 SCC modules. Conditioned analog signals are passed directly to the inputs of the DAQ device. SCC modules can also provide up to 300 V of working isolation to voltage and current output signals from the DAQ device. Optically isolated digital I/O modules can condition digital lines from the DAQ device or access them directly using the 42-pin screw terminal mounted inside the box. Relay modules add switching to your SCC DAQ system, and you can access analog output signals as well as timing and triggering signals from the DAQ device using feedthrough modules.

Portable, Modular Signal Conditioning Modules



Figure 1. SCC-TC01 and SCC-TC02 Thermocouple Input Modules (thermocouple plug not included)

NI SCC-TC Series Thermocouple Input

Model	Ch	Description	Part Number
SCC-TC01	1	Thermocouple, spade connector	777459-03
SCC-TC02	1	Thermocouple input	777459-04

Table 1. SCC-TC Series Modules

The National Instruments SCC-TC01 and SCC-TC02 are single-input modules for conditioning signals from a variety of thermocouple types, including J, K, T, B, E, N, R, and S, and millivolt inputs with a range of ±100 mV. The SCC-TC modules include a 2 Hz lowpass filter, an instrumentation amplifier with a gain of 100, and buffered outputs for maximum scanning rates by the multifunction DAQ device. The input circuitry of the SCC-TC modules also includes high-impedance bias resistors for open-thermocouple detection as well as handling both floating and ground-referenced thermocouples. The SCC-TC modules include an onboard thermistor for cold-junction compensation (See Figure 2).

When you install an SCC-TC in the SC-2345, the carrier routes the thermocouple signal and the cold-junction signal to two input channels of the DAQ device, channels X and X+8, respectively, where X is any channel 0 through 7. For example, if you install the module in socket J1 of the SC-2345, the carrier routes the thermocouple signal channel 0 and the cold-junction sensor output to channel 8.

Two versions of the SCC-TC are available. The SCC-TC01 includes a 2-prong uncompensated thermocouple jack that accepts any miniature or subminiature 2-prong male thermocouple plug. The SCC-TC02 includes a removable screw terminal plug that includes an additional connection for grounding thermocouple shields.



Figure 3. SCC-RTD01

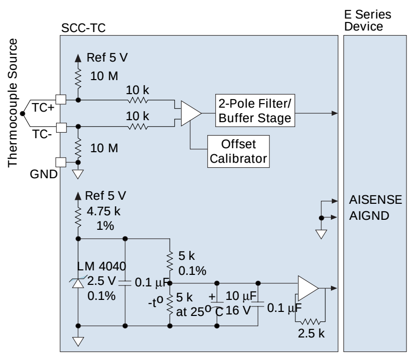
NI SCC-RTD01 RTD Input

Model	Ch	Description	Part Number
SCC-RTD01	2	2, 3, or 4-wire Pt RTD	777459-18

Table 2. SCC-RTD01 Module

The SCC-RTD01 is a dual-channel module that accepts 2, 3, or 4-wire platinum RTDs. Each channel of the SCC-RTD01 has an amplifier with a gain of 25 and a 30 Hz lowpass filter. In addition, the module has a 1 mA excitation source for powering the RTDs.

When you install the SCC-RTD01 in the SC-2345, the two output voltages are routed to two input channels of the multifunction DAQ device, channels X and X+8, where X is any channel 0 through 7. For example, if you install the module in the J1 socket of the SC-2345, the output voltages are routed to input channels 0 and 8 of the DAQ device (See Figure 4).



NOTE: GND available on SCC-TC02 only

Figure 2. Block Diagram of the SCC-TC01 and SCC-TC02

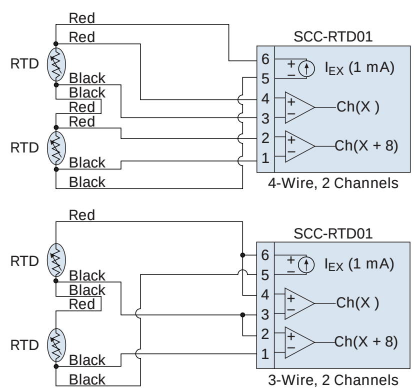


Figure 4. Block Diagram of the SCC-RTD01

Portable, Modular Signal Conditioning Modules

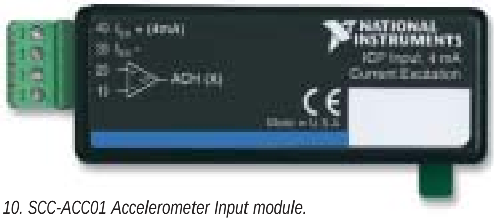


Figure 10. SCC-ACC01 Accelerometer Input module.

NI SCC-ACC01 Accelerometer Input

Model	Ch	Description	Part Number
SCC-ACC01	1	Accelerometer Input	777459-19

Table 4. SCC-ACC01 Accelerometer Input Module

The SCC-ACC01 is a single-channel module that accepts integrated circuit piezoelectric compatible sensors such as accelerometers and microphones. The SCC-ACC01 has an amplifier with a gain of two, a 0.8 Hz highpass filter, and a 19 kHz 3-pole Bessel lowpass filter. The maximum input range is ±5 V. In addition, this module has a 4 mA current source to power an integrated circuit piezoelectric accelerometer or microphone.

When you install the SCC-ACC01 into the SC-2345, the carrier routes the single output voltage to one input channel of the multifunction DAQ device, channel X, where X is 0 through 7. For example, if installed into the J1 socket of the SC-2345, the output voltage is routed to input channel 0 of the DAQ device (See Figure 11).

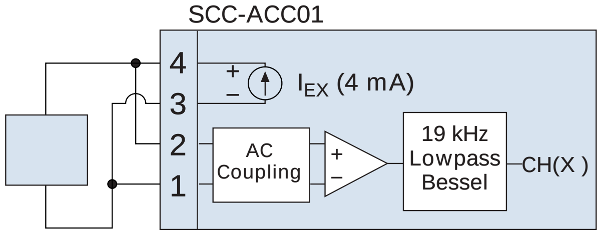


Figure 11. SCC-ACC01 Accelerometer Input Module



Figure 12. SCC-AI Series Isolated Analog Input Modules

NI SCC-AI Series Isolated Analog Input

Model	Ch	Input Range	Bandwidth	Part Number
SCC-AI01	2	±42 V	10 kHz	777459-20
SCC-AI02	2	±20 V	10 kHz	777459-21
SCC-AI03	2	±10 V	10 kHz	777459-22
SCC-AI04	2	±5 V	10 kHz	777459-23
SCC-AI05	2	±1 V	10 kHz	777459-24
SCC-AI06	2	±100 mV	10 kHz	777459-25
SCC-AI07	2	±50 mV	10 kHz	777459-26
SCC-AI13	2	±10 V	4 Hz	777459-27
SCC-AI14	2	±5 V	4 Hz	777459-28

Table 5. SCC-AI Isolated Analog Input Modules

The SCC-AI Series modules are dual-channel isolated analog input modules for reading input voltages from ±50 mV to ±42 V. Each channel of an SCC-AI module includes an instrumentation amplifier, a lowpass filter, and a potentiometer for calibration. These modules are installation rated for Category II, and provide safety working isolation of 300 V per module.

When you install an SCC-AI module in the SC-2345, the carrier routes the input signals to two input channels of the multifunction DAQ device, channels X and X+8, where X is 0 through 7.

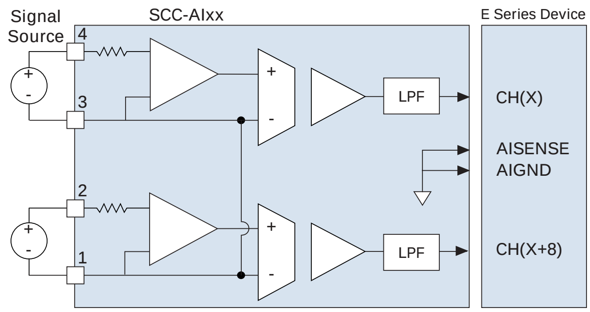


Figure 13. Block Diagram of the SCC-AI Series

Annex K: Ethernet Card PRO/100

Intel® Network Connectivity
Intel® PRO/100 S Desktop Adapter

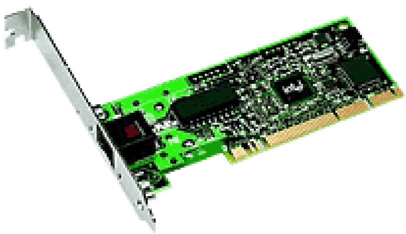
fast, managed 10/100 connections with accelerated LAN security

- Features IPSec encryption offloading using an integrated security co-processor.
- Utilizes Intel® SingleDriver™ technology for compatibility across Intel® 10/100 adapters, simplifying installation and maintenance.
- Provides advanced management capabilities for easy administration.

Order Codes

Single unit: PILA8460C3
5-pack: PILA8460C3PAK5
20-pack: PILA8460C3PAK20
80-pack: PILA8460C3PAK80

How to buy



take action

- Product Evaluation Program 11
- Intel® Network Adapter Selector
- Security Multimedia Presentation

the latest

- Intel® PRO/100 S Desktop Adapter Data Sheet PDF
- Tech Specs
- Doc Library
- eTesting Labs Report: Security Adapters Performance Comparison 22
- Intel® Security Solutions Deployment scenarios

Features	Benefits
High Performance LAN Security	Protection and performance
Encryption Offloading	Adapter offloads IPSec encryption/decryption from PC, conserving CPU resources for greater network performance
Intel® 82550 Fast Ethernet Controller with Integrated Encryption Co-processor	Combines network functions and encryption offloading into same silicon for improved performance and reliability
Windows* 2000 Optimization, IPSec Support	Improves performance of IPSec functionality in Windows 2000 operating systems through encryption offloading
Intel® Packet Protect II Software	Adds IPSec functionality to Windows NT* and Windows* 98 systems
3DES (168bit) Encryption33	Highest level of encryption widely available for data protection
Advanced Management Capabilities	Ease IT administration and reduce support costs
Wired for Management (WfM) 2.0 Enabled	Remote management across platforms
Wake on LAN* and Desktop Management Interface (DMI) 2.0	Remote troubleshooting and asset management
Pre-installed Intel® Boot Agent	Deploy and upgrade PCs remotely

Tivoli* agents	Fast, easy access to management applications
ACPI Compliant	Reduced power consumption
Intel® PROSet II Utility	Windows utility for easy setup
Intel® SingleDriver™ Technology	Common set of drivers across Intel® 10/100 network adapters simplifies setup and maintenance, and decreases driver conflicts among new and legacy systems
Supports All Major OSs and NOSs44	Compatible with your environment as your network evolves
Backward Compatible	Integrates with existing Intel network adapters and network-ready PCs with Intel® Fast Ethernet technology

1 US and Canada only
2 eTesting Labs, September 2000.
3 Unlawful to export encryption outside the U.S. or Canada except under an approved Department of Commerce export license or applicable license exception. For more information on export restrictions, visit www.bxa.doc.gov/encryption.
4 Go to www.intel.com/network/connectivity/resources/technologies/advanced_features.htm for the latest OS/NOS support.

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Annex L: Ethernet Card 82550

Developer

Hardware Design
Software Development
Download Software/Drivers
Design Support/Services
Events, Training & Pubs
R&D/Initiatives

Networking and Communications Design Components

- Product Index
- Design Components
- Design Solutions
- Related Sites
- Networking & Communications Support

Networking & Communications Building Blocks

82550 Fast Ethernet Multifunction Controller

The Intel® 82550 Fast Ethernet Multifunction PCI/CardBus Controller is a third generation fully integrated Fast Ethernet Media Access Controller (MAC)/ Physical Layer (PHY) device. The MAC offers a low-cost, high-performance 10/100 Mbps LAN solution. In addition, the 82550 requires low real estate, which is important when competing for precious board space. The 82550's baseline functionality is equivalent to that of the 82559 with the addition of an integrated IP Security (IPSec) encryption engine, and Alert on LAN* 2 functionality.

Highlights

- Intel Boot Agent
  Binary code for inclusion in BIOS (8255x PXE and RPL).

Resources

Get documentation or access design resources for this product.

Select one

Where to Buy

The 82550, with an integrated IP Security (IPSec) encryption engine and Alert on LAN functionality, is Intel's premium 10/100 Mbps network connectivity solution. It is designed for use in Network Interface Cards (NICs) and PC LAN on Motherboard (LOM) designs. The 82550 combines advanced security and manageability features to provide a secure and easily managed Fast Ethernet connectivity solution for today's networked environment.



The 82550 continues Intel's platform LAN technology leadership by integrating the following features: Triple Data Encryption Standard (3DES) IPSec encryption engine, Advanced Configuration and Power Interface (ACPI) 1.2A based power management, wake on Magic Packet*, wake on interesting packet and advanced System Management Bus (SMB) based manageability. The 82550 complies with Wired for Management (WfM) Specification 2.0, PC 01 and Server 00 specifications. The 82550 is pin-compatible with the 82559, allowing these designs to be upgraded.

Compare the 82550GY and 82550EY Fast Ethernet multifunction controllers and the 82559 Fast Ethernet controller.

Enhanced IP Support

- TCP, UDP, IPv4 checksum offload
- Received checksum verification
- IP Security support

Quality of Service (QoS)

- Multiple priority transmit queues

Optimum Integration for Lowest Cost Solution

- Integrated IP Security encryption engine
- Integrated IEEE 802.3 10BASE-T and 100BASE-TX compatible PHY
- 32-bit PCI/CardBus master interface
- Modem interface for combination solutions
- Integrated power management functions
- Thin BGA 15x15mm package

Wired for Management and Reduced Total Cost of Ownership

- Wired for Management support
- Integrated Alert on LAN 2 support
- Advanced Configuration Power Interface and PCI power management specifications compliance
- Wake on "interesting" packets and link status change support
- Magic Packet support
- Remote power-up support

High-Performance Networking Functions

- Early release
- Chained memory structure similar to the 82559, 82558, 82557 and 82596
- Improved dynamic transmit chaining with multiple priorities transmit queues
- Backward compatible software to the 82559, 82558 and 82557
- Full duplex support at both 10 and 100 Mbps operation
- IEEE 820.3u Auto-negotiation support
- 3 Kbyte transmit and 3 Kbyte receive FIFOs
- Fast back-to-back transmission support with minimum interframe spacing
- IEEE 802.3x 100BASE-TX Flow Control support
- Adaptive Technology

Low Power Features

- Advanced Power Management (APM) capabilities
- Low power +3.3 V device
- Efficient dynamic standby mode
- Deep power down support
- Clockrun protocol support

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Annex O: pHmeter CRISON GLP 21

Interface RS 232 C

Especificaciones.

Baud Rate:	9600 bps
Longitud palabra:	8 bits
Bits de Stop:	2 bits
Paridad:	Ninguna

Cómo activar la comunicación.

Desde la opción "SISTEMA" del GLP escoger "Salida RS 232" y "Ordenador".

Envío de datos del GLP hacia el PC.

Los datos de la calibración y las medidas se envían por el canal RS 232 en formato ASCII.

Las líneas de texto empiezan con STX (H02) seguido de todos los caracteres ASCII de la línea y finalizan con CR (H0D).

Las líneas de medida empiezan con ETX (H03) seguido de todos los caracteres ASCII de la línea y finalizan con CR (H0D).

Las líneas de Data logger empiezan con EOT (H04) seguido de todos los caracteres ASCII de la línea y finalizan con CR (H0D).

Ejemplo de medida:

```
H02 CRISON pHMETER GLP 21/22 V2.02 SN 727000 H0D
H02 Viernes, 26 Septiembre 1997          16:22 H0D
H02 MEDIDA POR ESTABILIDAD                 (F) H0D
H02 ------------------------------------------ H0D
H02 Electrodo 52-02 Núm. 01                    H0D
H02 CALIBRADO          26-09-97 14:48 (24.9°C) H0D
H0D
H02 Tampones  'Slope'  Sens. Pot.Asim. Tiempo  H0D
H02 técnicos  (mV/pH)  (%)   (mV)      (s)     H0D
H02 -------   -----    ---   -----     -----   H0D
H02 7.00,4.01  57.7    99.2   1.1        6     H0D
H02                       Agitación 12 %       H0D
H03 Código       pH     °C    Tiempo           H0D
H03 ------      ----   ----   ------           H0D
H03    1        5.01   19.8   00:09            H0D
H03    2        5.01   19.8   00:04            H0D
H02                                            H0D
H02                       Agitación 12 %       H0D
H0D ------------------------------------------ H0D
```

Ejemplo de calibración:

```
H02 CRISON pHMETER GLP 21/22 V2.02 SN727000 H0D
H02 Viernes, 26 Septiembre 1997       16:38 H0D
H02 CALIBRADO                               H0D
H02 --------------------------------------- H0D
H02 Electrodo 52-02 Núm. 01                 H0D
H02 CALIBRADO       26-09-97 16:38 (24.9°C) H0D
H0D
H02 Tampones  'Slope'  Sens. Pot.Asim. Tiempo H0D
H02 técnicos  (mV/pH)  (%)   (mV)      (s)    H0D
H02 -------   -----    ---   -----     -----  H0D
H02 7.00,4.01  57.7    99.2   1.1        6    H0D
H02                       Agitación 12 %      H0D
H02 --------------------------------------- H0D
H0D
```

Interface RS 232 bidireccional (en GLP 22).

La interface RS 232 bidireccional del GLP 22 permite, además de capturar los datos enviados, gobernar el instrumento desde un ordenador.

Software de comunicación CRISON.

CRISON ha desarrollado una aplicación (programa de comunicación pH-metros GLP - PC) para entornos Windows 3.1 y Windows 95. Esta aplicación facilita las tareas de transmisión y almacenamiento en un PC de los datos obtenidos con los GLP.

Accesorios.

Cat. nº	Descripción	
90-14	Kit para conexión de instrumentos GLP a PC, compuesto por disquette y cable (conector sub D 25 vías)	
90-28	Disquette de DEMO del programa de comunicación pH-metros GLP-PC incluyendo información RS.	Gratuito
90-29	Cable de interconexión pH-metros GLP-PC (conector sub D 25 vías)	
90-30	Disquette del programa de comunicación pH-metros GLP-PC, incluyendo información RS.	

Especificaciones técnicas

	GLP 21	GLP 22
Escalas de medida		
pH -2...16, mV ±2000, °C -20...150	•	
pH -2...16, mV ±2000, °C -20...150, mV relativos, mol / l 10^{-5}..10^{-1} (o ppm o g/l)		•
Resolución		
Estándar, 0.01 pH, 1mV, 0.1°C y seleccionable, 0.1 pH	•	•
Seleccionable, 0.001 pH, 0.1mV		•
Error de medida		
≤ 0.02pH, ≤ 1mV, ≤ 0.3 °C (±1 digito)	•	•
≤ 0.01pH, ≤ 0.5mV, ≤ 0.3 °C (±1 digito)		•
Reproducibilidad		
± 0.01pH, ±1mV, ±0.1 °C	•	•
± 0.001pH, ±0.1mV, ±0.1 °C		•
Compensación automática de Temperatura		
Por teclado o con sonda de temperatura	•	•
Posibilidades en calibración pH		
En 2 ó 3 puntos, validez 0 h....7 dias, datos por pantalla o impresora	•	•
Calibración especial, 1 punto cualquiera entre 0...14 pH	•	•
Aviso de caducidad, con recalibración forzosa (opcional)	•	•
Reconocimiento automático de tampones		
Técnicos (a 25°C) pH 2.00, 4.01, 7.00, 9.21, 10.90	•	•
NBS (a 25°C) pH 1.679, 4.006, 6.865, 9.180, 12.454	•	•
Criterios de aceptación de calibración (valores a 25°C)		
Pendiente 51...65 mV/pH, (sensibilidad 86...110%). Potencial de asimetría, ±40 mV (±0.7 pH)	•	•
Historial electrodo de pH		
Últimas calibraciones (10), nº de mediciones, tiempo en servicio, pH y temp. máx. y mín.		•
Modos de medida		
Por estabilidad, en continuo y por tiempo	•	•
Con límites máx. y mín. y punto final seleccionables. Aviso acústico	•	•
Programas de medida		
Uno fijo y uno modificable por el usuario	•	
Uno fijo y cuatro modificables por el usuario		•
"Data logger"		
Capacidad de almacenaje 447 lecturas, informes alfanuméricos y gráficos		•
Pantalla alfanumérica LCD retroiluminada		
4 lineas de 20 caracteres. Paso a "economode" a los 10 minutos	•	•
Idioma español, italiano, inglés o francés		
Seleccionable por el usuario	•	•
Reloj interno		
Fecha, hora y cronómetro	•	•
Entradas y salidas		
Electrodo de medida, conector BNC. Electrodo de referencia, banana Ø 4	•	•
CAT, tipo Pt 1000, conector telefónico o banana Ø 4	•	•
Interface teclado estándar de PC-AT, conector mini DIN	•	•
Interface RS 232C, unidireccional, conector telefónico	•	
Interface RS 232C, bidireccional,conector telefónico		•
Corriente polarizante, 10 μA (ej. para Karl Fischer), conector banana Ø 4	•	•
Salida analógica, seguidor potencial de electrodo, conector banana Ø 4	•	•
Control agitador CRISON, paro / marcha y velocidad, conector RCA	•	•
Alimentación externa, 12 Vcc / 275 mA	•	•
Condiciones ambientales permitidas		
Temperatura, 5...40 °C, humedad relativa máx. 95%, no condensada	•	•
Parámetros físicos		
Peso 1.580 g, dimensiones 180 x 215 x 130 mm	•	•

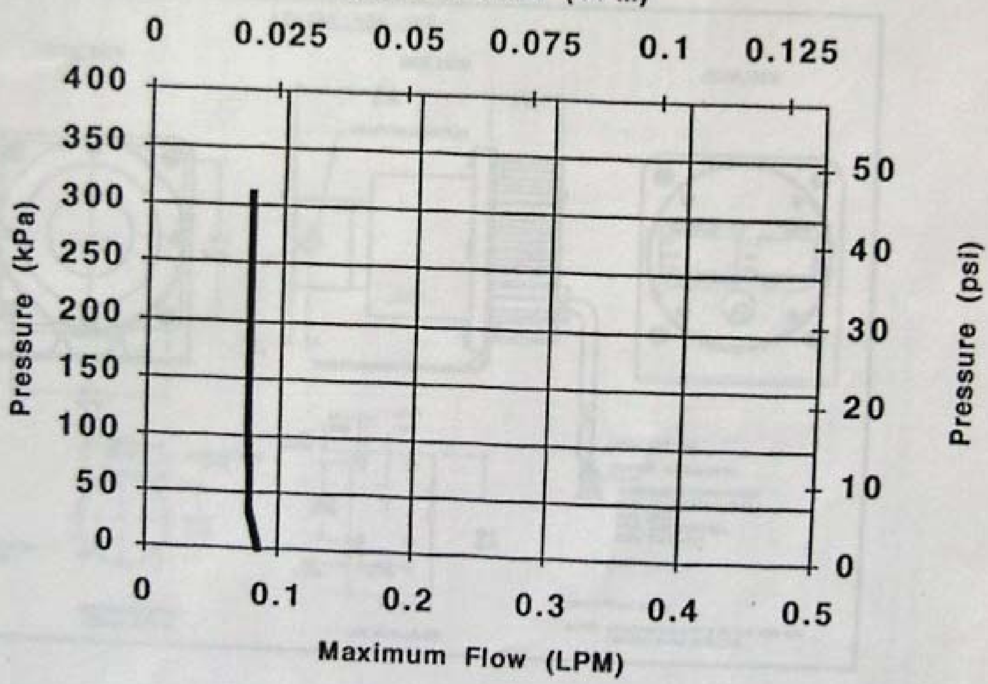
Annex Q: Pumps Micropump LG 187

MICROPUMP CORPORATION
PERFORMANCE SHEET

for: LG-187-0024
Pump/Motor Curve

Performance*	
Maximum Flow Rate:	85 ml/min
Maximum Differential Pressure:	690 kPa [100 psig] (Intermittent)
System Pressure:	2050 kPA [300 psig]
Suction Capabilities:	-93 kPa [28 in Hg]
Temperature Range:	0 °C to 80 °C [32 °F to 175 °F]
Viscosity Range:	Consult Factory
Current Requirements	
10 psi	45 psi
Flow: 80 ml/min (60-90)	75 ml/min (55-85)
Current: .44 amp (0.31-0.58)	0.54 amp (.40-.61)

LG-187-0024-83083



*Performance shown is based on actual performance testing, but should not be construed as a guaranteed value. Actual performance may vary, depending on fluid, temperatures and system operating conditions. (Performance Data Points @: Fluid/Temperature: Water @ 20 °C ± 2 °C; Control Voltage: 5V ± 0.1V; Supply Voltage: 24V ± 1V.

Micropump Corporation maintains a constant program of product improvement which may affect design and/or specifications. We reserve the right to make these changes without prior notice or liability. Product covered by warranty; contact manufacturer for details.

PUMP SPECIFICATIONS

Wetted Materials.........Pump body: 316 Stainless Steel (SS); Gears: carbon graphite; Seals: Teflon; Magnet: Teflon and encapsulated in 316 SS

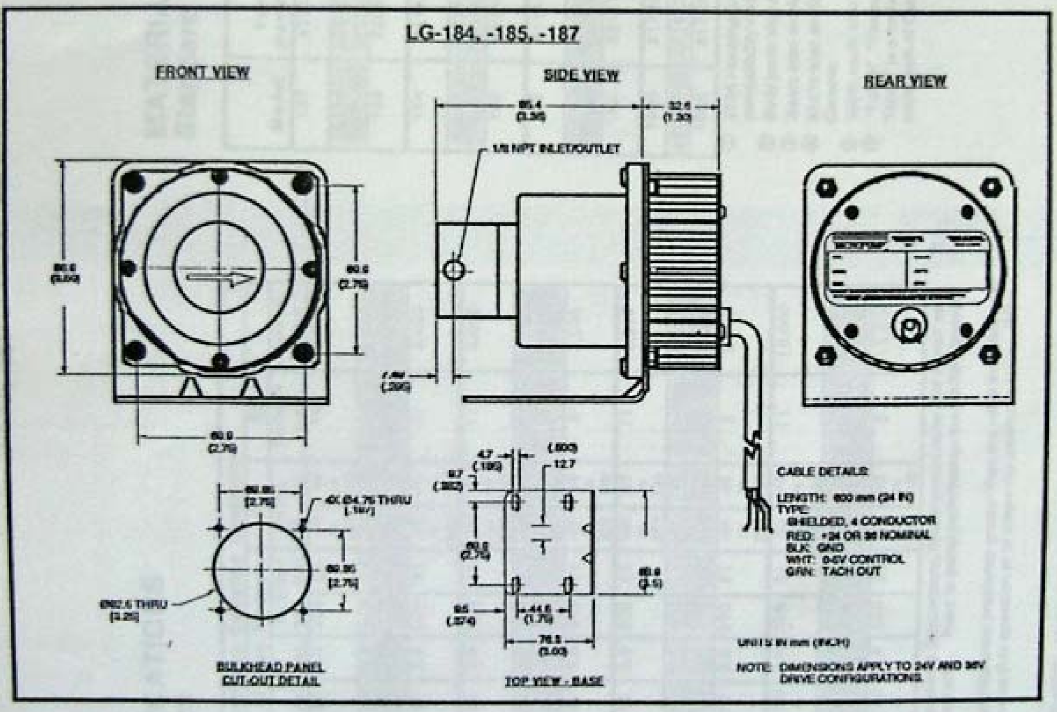
Ports ....1/8 inch NPT [F]

Weight ....Complete Unit (Pump/Motor/Controller) 2.65 lbs.

Drive Specifications	
Speed Range:	500 to 4500 rpm
Voltage Input:	23VDC to 28VDC
Power (@ nominal voltage):	45 Watts
Current Input:	2A max
Speed Control:	0-5 VDC
Tachometer Output:	0-6 volt square wave (rpm = x30)

NOTES:

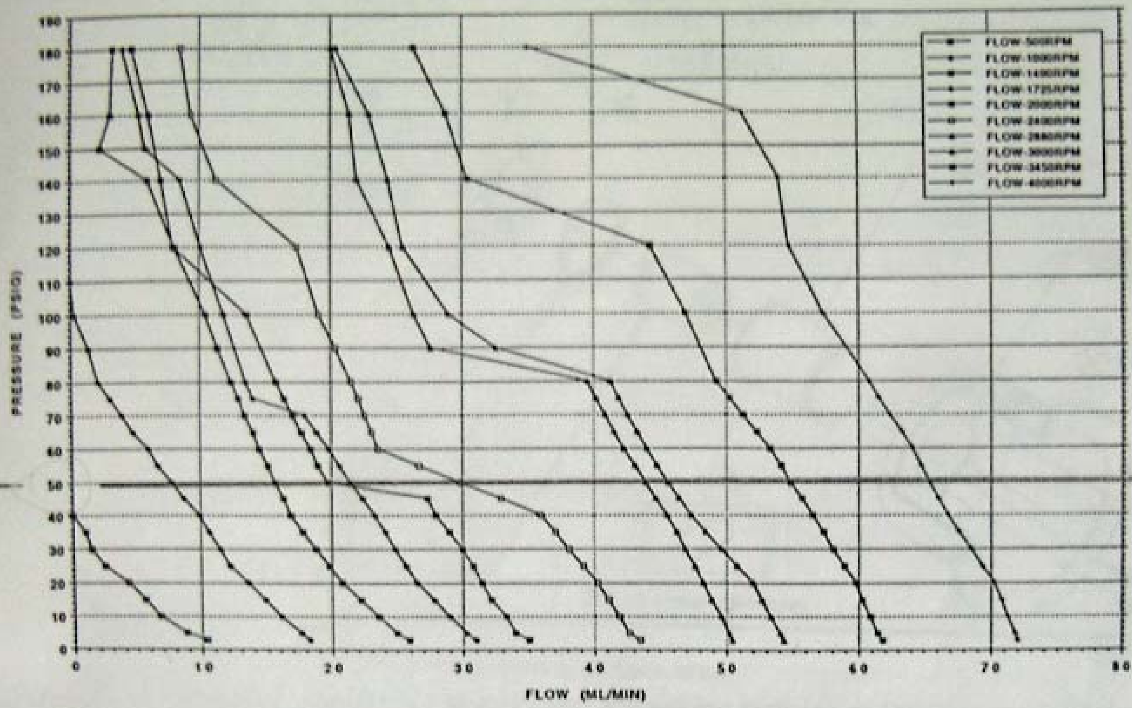
1. Motor gaskets/seals located at back plate/controller-housing interface and controller housing/bulkhead flange interface. These provide some protection against dust and moisture.
2. The drive may be described as TENV. The drive enclosure is NEMA Type 1 compliant.



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CURVAS CAUDAL/PRESION/RPM

PERFORMANCE CHART: MODEL 186, 187, 188
FLOW vs PRESSURE



MAX PRESION

* testing performed on water at 24°C (75°F) with pump part number 82092

*NOTE: Do not interpret data to be an indication of recommended operating parameters. Refer to the Performance Specification sheet for maximum recommended operating conditions.

**Performance is based on actual testing, but should not be construed as a guaranteed value. Actual performance may vary, depending on fluid temperature and system operating conditions. Micropump Corp. maintains a constant program of product improvement which may affect design and/or specifications.
We reserve the right to make these changes without prior notice or liability. Product covered by warranty; contact manufacturer for details.

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PERFORMANCE SPECIFICATIONS
Standard Series 180 Pumps

Model	Part Number	⑤ Maximum Operating Conditions										
		① Max Flow			② Max Pressure				③		④	
		ml/rev	1750 rpm gph	1750 rpm mlpm	ΔP psi	ΔP bar	System psi	System bar	Temp °F	Temp °C	Torque in-oz	Speed rpm
187	81112	.017	.48	30	50	3.5	300	21	-50 to 250	-45 to 120	11	8,000
186	82092	.017	.48	30	50	3.5	300	21	-50 to 250	-45 to 120	11	8,000
188	82093	.017	.48	30	50	3.5	300	21	-50 to 250	-45 to 120	3	8,000
184	81113	.042	1.2	75	50	3.5	300	21	-50 to 250	-45 to 120	11	8,000
181	82114	.042	1.2	75	50	3.5	300	21	-50 to 250	-45 to 120	11	8,000
180	82116	.042	1.2	75	50	3.5	300	21	-50 to 250	-45 to 120	3	8,000
185	81114	.084	2.4	150	50	3.5	300	21	-50 to 250	-45 to 120	11	8,000
183	82115	.084	2.4	150	50	3.5	300	21	-50 to 250	-45 to 120	11	8,000
182	82117	.084	2.4	150	50	3.5	300	21	-50 to 250	-45 to 120	3	8,000
1840	81726	.092	2.5	160	100	6.9	300	21	-50 to 250	-45 to 120	11	10,000
1830	81473	.092	2.5	160	100	6.9	300	21	-50 to 250	-45 to 120	11	10,000
1800	81725	.092	2.5	160	100	6.9	300	21	-50 to 250	-45 to 120	3	10,000

① Values shown above disregard variations due to pressure, temperature, fluid characteristics and should be used for pump comparison and estimating purposes only. Refer to pump performance curves for expected delivery at different pressure and viscosity.

② Although the pump may be capable of operating at differential pressures greater than the value indicated gear life will be reduced. Consult the factory for continuous duty operation at or above the maximum limits. PSI = (1/.0689) X (bar)

③ °F = (9/5 X °C) + 32

④ Values are approximate at room temperature 24°C (75°F). Higher torque rare earth magnets are available for applications where magnet decoupling is a problem due to fast startup, high viscosity, or high pressure.

⑤ Consult the factory on applications exceeding maximum operating conditions

⑥ Port size for all Series 180 pumps is 1/8" FNPT.

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MATERIALS OF CONSTRUCTION
Standard Series 180 Pumps

Model	Part Number	① Mounting Adapter	Wetted Materials of Construction				Internal Bypass
			② Body	③ Gears	④ Shafts	⑤ Seals	
187	81112	5508 Housing	316SS	Carbon Graphite	316SS	Teflon	no
186	82092	2301 Plate	316SS	Carbon Graphite	316SS	Teflon	no
188	82093	4546 Plate	316SS	Carbon Graphite	316SS	Teflon	no
184	81113	5508 Housing	316SS	Carbon Graphite	316SS	Teflon	no
181	82114	2301 Plate	316SS	Carbon Graphite	316SS	Teflon	no
180	82116	4546 Plate	316SS	Carbon Graphite	316SS	Teflon	no
185	81114	5508 Housing	316SS	Carbon Graphite	316SS	Teflon	no
183	82115	2301 Plate	316SS	Carbon Graphite	316SS	Teflon	no
182	82117	4546 Plate	316SS	Carbon Graphite	316SS	Teflon	no
1840	81726	5508 Housing	316SS	Ryton®	316SS	Teflon	no
1830	81473	2301 Plate	316SS	Ryton®	316SS	Teflon	no
1800	81725	4546 Plate	316SS	Ryton®	316SS	Teflon	no

① 5508 Housing (compatible with 56C adapter kit p/n 81518). Refer to the pumphead master price list for compatibility code of the various mounting adapters.

② Body parts also available in: Alloy 20, Hastelloy B or C, Tantalum, Titanium, Monel, Inconel®, Ryton,

③ Gears also available in: Stainless Steel, Teflon®, Ryton®, PEEK, Vespel®, Polyethylene, Delrin®, V

④ Shafts also available in: Alloy 20, Hastelloy B or C, Tantalum, Titanium, Monel, Inconel® Alloy Steel, Sa Ceramic.

⑤ Static seals also available in Buna-N®, Ethylene Propylene, Neoprene®, Silicone, Viton®.

⑥ "Teflon", "Vespel", "Kalrez", "Neoprene", and "Viton", are trademarks of E.I. duPont de Nemours & Co "Ryton" is a trademark of Phillips Petroleum Co. "Hastelloy" is a trademark of Haynes International. "Ve trademark of Celanese Corp. "Carpenter" and 20Cb-3 are trademarks of Carpenter Technology.

Polypropylene Tubing

Series PP: Laboratory Grade—FDA, NSF Listed
Series PPB: Ultraviolet Light Resistant

- Acid Resistant
- High Temperature
- Medium Pressures
- Chemical Resistant
- Corrosion Resistant
- Flexible
- Dimensionally Stable

Parflex polypropylene tubing may be used at higher temperatures and working pressures than polyethylene tubing. Resistance to hot water and hot corrosive acids is excellent. Polypropylene tubing will last many times longer than nylon tubing in hot water service. Parflex polypropylene tubing is available in white, black, or ultraviolet resistant black, and has good resistance to vegetable oils. Parflex polypropylene tubing has water absorption of less than .01% and has excellent resistance to environmental stress cracking. White PP series polypropylene meets FDA and NSF-51 requirements for food contact and potable water. Black polypropylene FDA and NSF-51 listed tubing is available upon special request. PPB series tubing has superior ultraviolet resistance.

Suggested operating temperatures, depending upon conditions, are 0°F (-18°C) to +200°F (+93°C).

How to order Parflex polypropylene tubing

Example: **PP-86-0250** is 1/2" O. D. x 3/8" I. D.

P P – 8 6 – 0250

- 0250 — Coil Length in feet
- 6 — I. D. of Tubing in sixteenths of an inch
- 8 — O. D. of Tubing in sixteenths of an inch
- P P — Polypropylene

Fitting Recommendations:

- Parker TrueSeal™ fittings
- Parker Fast & Tite® fittings
- Parker Brass Fittings available from
  Brass Products Division
  Otsego, Michigan
  Phone (616) 694-9411

Part Number	Color	Nom. Tube O. D. in.	Nom. Tube I. D. in.	Avg. Wall Thick. in.	Reel Length ft.	Working Pressure at 73°F psi	Min. Burst Pressure at 73°F psi	Min. Bend Radius in.	Weight lbs. Per 100 ft.
PP-21-1000 PPB-21-1000	White Black	1/8	.080	.023	1000	350	1400	1/2	0.28
PP-32-0500 PPB-32-0500	White Black	3/16	.120	.034	500	350	1400	3/4	0.62
PP-43-0500 PPB-43-0500	White Black	1/4	.170	.040	500	300	1200	1	1.01
PP-53-0500 PPB-53-0500	White Black	5/16	.187	.062	500	350	1400	1-1/4	1.87
PP-64-0500 PPB-64-0500	White Black	3/8	.250	.062	500	300	1200	1-1/4	2.35
PP-86-0250 PPB-86-0250	White Black	1/2	.375	.062	250	225	900	2-1/2	3.28
PP-108-0100 PPB-108-0100	White Black	5/8	.500	.062	100	175	700	4	4.22